

# FLUKE 83,85,87 Multimeters

## Service Manual

PN 834168  
April 1989  
Rev 5, 3/96  
© 1989, 1994, 1996 Fluke Corporation, All rights reserved. Printed in U.S.A.  
All product names are trademarks of their respective companies.

**FLUKE.**®

## Table of Contents

SECTION	TITLE	PAGE
1	INTRODUCTION AND SPECIFICATIONS .....	1-1
1-1.	INTRODUCTION .....	1-1
1-2.	ORGANIZATION OF THE SERVICE MANUAL .....	1-1
1-3.	CONVENTIONS .....	1-1
1-4.	SPECIFICATIONS .....	1-2
2	THEORY OF OPERATION .....	2-1
2-1.	INTRODUCTION .....	2-1
2-2.	FUNCTIONAL BLOCK DESCRIPTION .....	2-1
2-3.	DETAILED CIRCUIT DESCRIPTION .....	2-1
2-4.	Input Overload Protection .....	2-1
2-5.	Rotary Knob Switch and Potentiometer .....	2-3
2-6.	Input Signal Conditioning Circuits .....	2-3
2-7.	VOLTS .....	2-3
2-8.	OHMS .....	2-3
2-9.	Analog Section of Integrated Multimeter IC (U4) .....	2-3
2-10.	Digital Section of Integrated Multimeter IC (U4) .....	2-6
2-11.	Microcomputer Control .....	2-6
2-12.	Peripherals to U4 .....	2-9
2-13.	AC BUFFER .....	2-9
2-14.	AC CONVERTER .....	2-9
2-15.	RMS CONVERTER .....	2-9
2-16.	ACTIVE FILTER .....	2-9
2-17.	A/D CONVERTER .....	2-9
2-18.	BEEPER .....	2-9
2-19.	SYSTEM REFERENCE .....	2-9
2-20.	POWER SUPPLY .....	2-9
2-21.	PEAK HOLD .....	2-10
2-22.	Display .....	2-10

(continued on page ii)

TABLE OF CONTENTS, *continued*

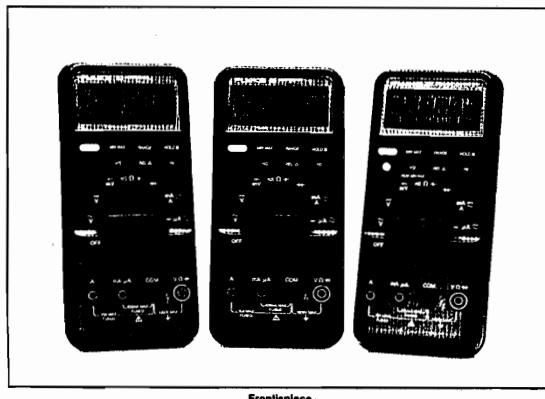
SECTION	TITLE	PAGE
3	<b>MAINTENANCE</b>	3-1
3-1.	INTRODUCTION	3-1
3-2.	REQUIRED TOOLS AND EQUIPMENT	3-1
3-3.	OPERATOR MAINTENANCE	3-1
3-4.	Case Disassembly	3-1
3-5.	Circuit Assembly Removal and Installation	3-1
3-6.	Case Reassembly	3-3
3-7.	Battery Replacement	3-3
3-8.	Fuse Test	3-5
3-9.	Fuse Replacement	3-5
3-10.	Cleaning	3-5
3-11.	INPUT TERMINALS	3-5
3-12.	ROTARY SWITCH	3-5
3-13.	PERFORMANCE TEST	3-6
3-14.	Setup	3-6
3-15.	Display Test	3-6
3-16.	Rotary Switch Test	3-6
3-17.	AC Voltage Test	3-6
3-18.	Frequency Test	3-7
3-19.	Frequency Sensitivity and Trigger Level Test	3-8
3-20.	DC Voltage Test	3-9
3-21.	1-MS MIN MAX Test (Model 87 only)	3-9
3-22.	mV DC Tests	3-9
3-23.	Ohms Tests	3-9
3-24.	Capacitance Tests	3-9
3-25.	Diode Test	3-10
3-26.	mA Tests	3-10
3-27.	$\mu$ A Tests	3-11
3-28.	A Tests	3-11
3-29.	CALIBRATION	3-11
3-30.	Models 83 and 85 Calibration	3-11
3-31.	Model 87 Calibration	3-13
3-32.	TROUBLESHOOTING	3-13
3-33.	Servicing Surface-Mount Assemblies	3-13
3-34.	TROUBLESHOOTING - POWER SUPPLY	3-14
3-35.	Common (Shunt) Regulator Troubleshooting	3-14
3-36.	Vdd (Series) Regulator Troubleshooting	3-15
4	<b>LIST OF REPLACEABLE PARTS</b>	4-1
4-1.	INTRODUCTION	4-3
4-2.	HOW TO OBTAIN PARTS	4-3
4-3.	MANUAL STATUS INFORMATION	4-3
4-4.	NEWER INSTRUMENTS	4-3
4-5.	SERVICE CENTERS	4-3
5	<b>SCHEMATICS</b>	5-1

**List of Tables**

TABLE	TITLE	PAGE
1-1.	Specifications, Models 83 and 85	1-3
1-2.	Specifications, Model 87	1-7
2-1.	Typical Voltage Levels and Tolerance	2-10
3-1.	Required Equipment	3-2
3-2.	Rotary Switch Test	3-6
3-3.	AC Voltage Test	3-7
3-4.	Frequency Test	3-7
3-5.	Frequency Counter Sensitivity and Trigger Level Tests	3-8
3-6.	DC Voltage Test	3-8
3-7.	1-MS MIN MAX Test	3-9
3-8.	Ohms Tests	3-9
3-9.	Capacitance Tests	3-10
3-10.	mA Tests	3-10
3-11.	$\mu$ A Tests	3-11
3-12.	A Tests	3-11
3-13.	Functional Description of Power Supply Components	3-14
3-14.	Voltage Levels	3-14
5-1.	Signal Abbreviations	5-3

## List of Illustrations

FIGURE	TITLE	PAGE
	Frontispiece	
2-1.	Overall Functional Block Diagram	2-2
2-2.	A/D Conversion	2-4
2-3.	Capacitance Measurement Elements	2-5
2-4.	Digital Circuitry Within U4	2-7
2-5.	Frequency Counter Elements	2-8
3-1.	Battery and Fuse Replacement	3-3
3-2.	Assembly Details	3-4
3-3.	Display Test	3-6
3-4.	Calibration Adjustment Points	3-12
3-5.	Simplified Power Supply Schematic	3-16



Frontispiece

## Section 1

### Introduction and Specifications

#### 1-1. INTRODUCTION

This manual covers servicing information for Fluke multimeter Models 83, 85, and 87. This service manual will prove useful for tasks ranging from routine maintenance to troubleshooting and repair. Specifications, theory of operation, calibration routines, testing and troubleshooting procedures, parts replacement information, and schematic diagrams are provided.

A meter under warranty will be promptly repaired or replaced (at Fluke's option) and returned at no charge. See the registration card for warranty terms. If the warranty has lapsed, the meter will be repaired and returned for a fixed fee. Contact the nearest Service Center for information and prices. A list of U.S. and International Service Centers is included at the end of Section 4 of this manual.

1-2. ORGANIZATION OF THE SERVICE MANUAL  
The following descriptions for the various sections serve to introduce the manual.

**SECTION 1. INTRODUCTION AND SPECIFICATIONS**  
This section describes both use of the Service Manual and application of special terminology (conventions) to describe the meter's circuitry. A complete set of specifications appears at the end of this section.

**SECTION 2. THEORY OF OPERATION**  
This section first categorizes instrument circuitry into functional blocks, with a description of each block's role in overall operation. A detailed circuit description is then given for each block. These descriptions explore operation to the component level and fully support troubleshooting and repair procedures defined in Section 3.

#### SECTION 3. MAINTENANCE

Provides complete maintenance information, from general maintenance and cleaning instructions to detailed troubleshooting and repair procedures to the component level. Troubleshooting and repair procedures rely closely on both the Theory of Operation presented in Section 2 and the Schematic Diagrams shown in Section 5.

#### SECTION 4. LIST OF REPLACEABLE PARTS

Includes parts lists for all standard assemblies. Information on how and where to order parts is also provided.

#### SECTION 5. SCHEMATIC DIAGRAMS

Includes schematic diagrams for all assemblies. A list of mnemonic definitions is also included to aid in identifying signal name abbreviations.

#### 1-3. CONVENTIONS

Throughout the manual, certain notational conventions are used. A summary of these conventions follows:

- Instrument Reference

When the discussion involves common features of the Fluke 80 Series multimeters, the term multimeter is used, and the model number is not used. Where features differ among models, further identification is made by model number (Model 83, 85, or 87).

- Printed Circuit Assembly

The term pca is used to represent a printed circuit board and its attached parts.

- Signal Logic Polarity

Signal names followed by a - are active (or asserted) low. Signals not so marked are active high.

- Circuit Nodes

Individual pins or connections on a component are specified with a dash (-) following the component reference designator. For example, pin 19 of U30 would be U30-19.

- User Notation

Generally, buttons to be pressed, function positions to select, input terminals to use, and

display notation to be read are presented in this manual as they are seen on the multimeter. However, one button on the Model 83/85 and two buttons on the Model 87 use no terminology and are identified by color (blue or yellow) in this manual.

Special terms (mnemonics) used in text descriptions of multimeter circuitry correspond to terms used on the schematic diagrams in Section 5.

#### 1-4. SPECIFICATIONS

Specifications for Models 83 and 85 are presented in Table 1-1. Model 87 specifications are presented in Table 2-2.

Table 1-1. Specifications, Models 83 and 85

FUNCTION	RANGE	RESOLUTION	ACCURACY*		
			50 Hz to 60 Hz	45 Hz to 1 kHz	1 kHz - 5 kHz
V (Fluke 83)	400.0 mV	0.1 mV	±(1.0% + 4)	±(1.5% + 4)	±(2.0% + 4)
	4.000V	0.001V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)
	40.00V	0.01V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)
	400.0V	0.1V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)
	1000V	1V	±(1.0% + 3)	±(2.5% + 3)	±(2.5% + 3)
V (Fluke 85)	400.0 mV	0.1 mV	±(0.5% + 4)	±(1.0% + 4)	±(2.0% + 4)
	4.000V	0.001V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)
	40.00V	0.01V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)
	400.0V	0.1V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)
	1000V	1V	±(0.5% + 2)	±(2.0% + 2)	±(2.0% + 2)
V (Fluke 83)	4.000V	0.001V	±(0.3% + 1)	±(0.1% + 1)	±(0.1% + 1)
	40.00V	0.01V	±(0.3% + 1)	±(0.1% + 1)	±(0.1% + 1)
	400.0V	0.1V	±(0.3% + 1)	±(0.1% + 1)	±(0.1% + 1)
	1000V	1V	±(0.3% + 1)	±(0.1% + 1)	±(0.1% + 1)
	400.0 mV	0.1 mV	±(0.3% + 1)	±(0.1% + 1)	±(0.1% + 1)
Ω	400.0Ω	0.1Ω	±(0.4% + 1)	±(0.2% + 1)	±(0.2% + 1)
	4.000 kΩ	0.001 kΩ	±(0.4% + 1)	±(0.2% + 1)	±(0.2% + 1)
	40.00 kΩ	0.01 kΩ	±(0.4% + 1)	±(0.2% + 1)	±(0.2% + 1)
	400.0 kΩ	0.1 kΩ	±(0.4% + 1)	±(0.2% + 1)	±(0.2% + 1)
	4.000 MΩ	0.001 MΩ	±(0.4% + 1)	±(0.2% + 1)	±(0.2% + 1)
	40.00 MΩ	0.01 MΩ	±(1% + 3)	±(1% + 3)	±(1% + 3)
	400.0 nS	0.01 nS	±(1% + 10)	±(1% + 10)	±(1% + 10)
TYPICAL OHMS SHORT CIRCUIT CURRENT					
Range	400	4k	40k	400k	4M
Current	700 μA	170 μA	20 μA	2 μA	.2 μA
Range	40M				
Current	.2 μA				

1 Accuracy is given as  $\pm[(\% \text{ of reading}) + (\text{number of least significant digits})]$  at 16°C to 28°C with relative humidity up to 90%, for a period of one year after calibration. AC conversions are ac-coupled, average responding, and calibrated to the rms value of a sine wave input.

\* Below a reading of 200 counts, add 10 digits.

Table 1-1. Specifications, Models 83 and 85 (cont)

FUNCTION	RANGE	RESOLUTION	ACCURACY <sup>2</sup>	
			Fluke 83	Fluke 85
Capacitance	5.00 nF	0.01 nF	$\pm(1\% + 3)$	
	0.0500 $\mu$ F	0.0001 $\mu$ F	$\pm(1\% + 3)$	
	0.500 $\mu$ F	0.001 $\mu$ F	$\pm(1\% + 3)$	
	5.00 $\mu$ F	0.01 $\mu$ F	$\pm(1\% + 3)$	
Diode Test	3.000V	0.001V	$\pm(2\% + 1)$	
FUNCTION	RANGE	RESOLUTION	ACCURACY	BURDEN VOLTAGE TYPICAL
mA ~ (45 Hz to 2 kHz)	40.00 mA	0.01 mA	$\pm(1.2\% + 2)$	1.6 mV/mA
	400.0 mA	0.1 mA	$\pm(1.2\% + 2)$	1.6 mV/mA
	4000 mA	1 mA	$\pm(1.2\% + 2)$	0.03 V/A
	10.00A <sup>3</sup>	0.01A	$\pm(1.2\% + 2)$	0.03 V/A
	40.00 mA	0.01 mA	$\pm(0.4\% + 2)$	1.6 mV/mA
mA m	400.0 mA	0.1 mA	$\pm(0.4\% + 2)$	1.6 mV/mA
	4000 mA	1 mA	$\pm(0.4\% + 2)$	0.03 V/A
	10.00A <sup>3</sup>	0.01A	$\pm(0.4\% + 2)$	0.03 V/A
	400.0 $\mu$ A	0.1 $\mu$ A	$\pm(1.2\% + 2)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	1 $\mu$ A	$\pm(1.2\% + 2)$	100 $\mu$ V/ $\mu$ A
$\mu$ A (45 Hz to 2 kHz)	400.0 $\mu$ A	0.1 $\mu$ A	$\pm(0.6\% + 2)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	0.1 $\mu$ A	$\pm(0.4\% + 3)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	1 $\mu$ A	$\pm(0.4\% + 2)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	1 $\mu$ A	$\pm(0.2\% + 2)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	1 $\mu$ A	$\pm(0.2\% + 2)$	100 $\mu$ V/ $\mu$ A
FUNCTION	RANGE	RESOLUTION	ACCURACY	
Frequency (0.5 Hz to 200 kHz, pulse width >2 $\mu$ s)	199.99	0.01 Hz	$\pm(0.005\% + 1)$	
	1999.9	0.1 Hz	$\pm(0.005\% + 1)$	
	1999.9 kHz	0.001 kHz	$\pm(0.005\% + 1)$	
	199.99 kHz	0.01 kHz	$\pm(0.005\% + 1)$	
	>200 kHz	0.1 kHz	Unspecified	

<sup>2</sup> With film capacitor or better using Relative mode to zero residual  
<sup>3</sup> 10A continuous, 20A for 30 seconds maximum

Table 1-1. Specifications, Models 83 and 85 (cont)

FREQUENCY COUNTER SENSITIVITY AND TRIGGER LEVEL				
INPUT RANGE	MINIMUM SENSITIVITY (RMS SINEWAVE)		APPROXIMATE TRIGGER LEVEL (DC VOLTAGE FUNCTION)	
(Maximum input for specified accuracy = 10X Range or 1000V)	5 Hz-200 kHz	0.5 Hz-200 kHz		
400 mV dc	70 mV (to 400 Hz)	70 mV (to 400 Hz)		40 mV
400 mV ac	150 mV	150 mV		—
4V	0.3V	0.7V		1.7V
40V	3V	7V		4V
400V	30V	70V ( $\leq$ 140 kHz)		40V
1000V	300V	700V ( $\leq$ 14 kHz)		400V
Duty Cycle	0.1 to 99.9%	(0.5 Hz to 200 kHz, pulse width $>2 \mu$ s)		
Accuracy:	Within $\pm(0.05\% \text{ per kHz} + 0.1\%)$ of full scale for a 5V logic family input on the 4V dc range.			
	Within $\pm(0.06 \times \text{Voltage Range} / \text{Input Voltage}) \times 100\%$ of full scale for sine wave inputs on ac voltage ranges.			
FUNCTION	OVERLOAD PROTECTION <sup>4</sup>	INPUT IMPEDANCE (nominal)	COMMON MODE REJECTION RATIO (1 k $\Omega$ unbalance)	NORMAL MODE REJECTION RATIO
$\overline{mV}$	1000V rms	10 M $\Omega$ <100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\overline{mV}$	1000V rms	10 M $\Omega$ <100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\overline{V}$	1000V rms	10 M $\Omega$ <100 pF (ac-coupled)	>60 dB, dc to 60 Hz	
$\Omega$		OPEN CIRCUIT TEST VOLTAGE	FULL SCALE VOLTAGE	SHORT CIRCUIT CURRENT
		To 4.0 M $\Omega$	40 M $\Omega$ or nS	
	1000V rms <sup>5</sup>	<1.3V dc	<450 mV dc	<1.3V dc
Diode Test	1000V rms <sup>6</sup>	<3.9V dc	3.000V dc	1.0 mA typical

5 10<sup>7</sup> V Hz max

6 For circuits &lt; 0.3A short circuit, 660V for high energy circuits.

Table 1-1. Specifications, Models 83 and 85 (cont)

NOMINAL RESPONSE		ACCURACY (5% to 100% of range)
MIN MAX Recording	100 ms to 80%	Specified accuracy $\pm 12$ digits for changes $>200$ ms in duration ( $\pm 40$ digits in AC with beeper on)
	1 s	Same as specified accuracy for changes $>2$ seconds in duration ( $\pm 40$ digits in AC with beeper on)
<b>FUSE PROTECTION</b>		
mA or $\mu$ A		MAXIMUM VOLTAGE BETWEEN ANY TERMINAL AND EARTH GROUND
A		1000 Volts
Display		
Digital: 4000 counts, updates 4/sec Analog: 43 segments, updates 40/sec Frequency: 19,999 counts, updates 3/sec @ $> 10$ Hz		
Operating Temperature		
-20°C to 55°C		
Storage Temperature		
-40°C to 60°C		
Temperature Coefficient		
0.05 x (specified accuracy) / °C (<18°C or >28°C)		
Electromagnetic Compatibility		
In an RF field of 1 V/m on all ranges and functions: Total Accuracy = Specified Accuracy + 0.5% of range. Performance above 1 V/m is not specified.		
Relative Humidity		
0% to 90% (0°C to 35°C)		
0% to 70% (35°C to 55°C)		
Battery Type		
9V, NEDA 1604 or 6F22 or 006P		
Battery Life		
500 hrs typical with alkaline		
Shock, Vibration		
Per MIL-T-28800 for a Class 2 Instrument		
Size (HxWxL)		
1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)		
With Holster and Flex-Stand:		
2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)		
Weight		
12.5 oz (355g)		
With Holster and Flex-Stand:		
22.0 oz (624g)		
Safety		
Designed to Protection Class II per IEC 348, ISA-DS82, and UL1244		

Table 1-2. Specifications, Model 87

FUNCTION	RANGE	RESOLUTION	ACCURACY*			
			50 Hz to 60 Hz	45 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 20 kHz
V	400.0 mV	0.1 mV	$\pm(0.7\% + 4)$	$\pm(1.0\% + 4)$	$\pm(2.0\% + 4)$	$\pm(2.0\% + 20)$
	4.000V	0.001V	$\pm(0.7\% + 2)$	$\pm(1.0\% + 4)$	$\pm(2.0\% + 4)$	$\pm(2.0\% + 20)$
	40.00V	0.01V	$\pm(0.7\% + 2)$	$\pm(1.0\% + 4)$	$\pm(2.0\% + 4)$	$\pm(2.0\% + 20)$
	400.0V	0.1V	$\pm(0.7\% + 2)$	$\pm(1.0\% + 4)$	$\pm(2.0\% + 4)$	$\pm(2.0\% + 20)$
	1000V	1V	$\pm(0.7\% + 2)$	$\pm(1.0\% + 4)$	$\pm(2.0\% + 4)$	unspecified
V	4.000V	0.001V			$\pm(0.1\% + 1)$	
	40.00V	0.01V			$\pm(0.1\% + 1)$	
	400.0V	0.1V			$\pm(0.1\% + 1)$	
	1000V	1V			$\pm(0.1\% + 1)$	
mV	400.0 mV	0.1 mV			$\pm(0.1\% + 1)$	
	40.00 mV	0.001V			$\pm(0.2\% + 1)$	
$\Omega$	4.000 k $\Omega$	0.1 k $\Omega$			$\pm(0.2\% + 1)$	
	4.000 k $\Omega$	0.001 k $\Omega$			$\pm(0.2\% + 1)$	
	40.00 k $\Omega$	0.01 k $\Omega$			$\pm(0.2\% + 1)$	
	400.0 k $\Omega$	0.1 k $\Omega$			$\pm(0.2\% + 1)$	
	4.000 M $\Omega$	0.001 M $\Omega$			$\pm(0.2\% + 1)$	
	40.00 M $\Omega$	0.01 M $\Omega$			$\pm(1\% + 3)$	
(nS)			40.00 nS	0.01 nS	$\pm(1\% + 10)$	
Capacitance					$\pm(1\% + 3)$	
5.00 nF			0.01 nF		$\pm(1\% + 3)$	
0.0500 $\mu$ F			0.0001 $\mu$ F		$\pm(1\% + 3)$	
0.500 $\mu$ F			0.001 $\mu$ F		$\pm(1\% + 3)$	
5.00 $\mu$ F			0.01 $\mu$ F		$\pm(1\% + 3)$	
Diode Test			3.000V	0.001V	$\pm(2\% + 1)$	
FUNCTION						
RANGE						
RESOLUTION						
ACCURACY						
BURDEN VOLTAGE TYPICAL						
mA	40.00 mA	0.01 mA			$\pm(1.0\% + 2)$	1.6 mV/mA
	400.0 mA	0.1 mA			$\pm(1.0\% + 2)$	1.6 mV/mA
	4000 mA	1 mA			$\pm(1.0\% + 2)$	0.03 V/A
	10.00A <sup>4</sup>	0.01A			$\pm(1.0\% + 2)$	0.03 V/A
mA	40.00 mA	0.01 mA			$\pm(0.2\% + 2)$	1.6 mV/mA
	400.0 mA	0.1 mA			$\pm(0.2\% + 2)$	1.6 mV/mA
	4000 mA	1 mA			$\pm(0.2\% + 2)$	0.03 V/A
	10.00A <sup>4</sup>	0.01A			$\pm(0.2\% + 2)$	0.03 V/A
TYPICAL OHMS SHORT CIRCUIT CURRENT						
Range 400 4k 40k 400k 4M 40M						
Current 700 $\mu$ A 170 $\mu$ A 20 $\mu$ A 2 $\mu$ A .2 $\mu$ A .2 $\mu$ A						

1. Accuracy is given as  $\pm(1\% \text{ of reading})/(\text{number of first significant digit})$  at 10°C to 20°C, with relative humidity up to 90%, for a period of one year after calibration. In the case of resistance, multiply the number of first significant digits (counts) by 10. AC components are ac-coupled for the responding, calibrated to the instrument at the wave form and valid from 5% to 100% of range. AC crest factor can be up to 3 at full scale, 8 at half scale. For non-sinusoidal wave forms add 12% Rdg x 2% Fd typical, for a crest factor up to 3.

2. Below 10% of range, add 6 digits.

3. With film capacitor or better using Relative mode to zero residual.

4. 10A continuous, 20A for 30 seconds maximum.

Table 1-2. Specifications, Model 87 (cont)

FUNCTION	RANGE	RESOLUTION	ACCURACY	BURDEN VOLTAGE TYPICAL
$\frac{\partial A}{\partial t}$ (45 Hz to 2 kHz)	400.0 $\mu$ A	0.1 $\mu$ A	$\pm(1.0\% + 2)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	1 $\mu$ A	$\pm(1.0\% + 2)$	100 $\mu$ V/ $\mu$ A
$\frac{\partial A}{\partial t}$	400.0 $\mu$ A	0.1 $\mu$ A	$\pm(0.2\% + 3)$	100 $\mu$ V/ $\mu$ A
	4000 $\mu$ A	1 $\mu$ A	$\pm(0.2\% + 2)$	100 $\mu$ V/ $\mu$ A
FUNCTION	RANGE	RESOLUTION	ACCURACY	
Frequency (0.5 Hz to 200 kHz, pulse width $>2 \mu$ s)	199.9	0.01 Hz	$\pm(0.005\% + 1)$	
	1999.9	0.1 Hz	$\pm(0.005\% + 1)$	
	19.999 kHz	0.001 kHz	$\pm(0.005\% + 1)$	
	199.99 kHz	0.01 kHz	$\pm(0.005\% + 1)$	
	$>200$ kHz	0.1 kHz	Unspecified	
FREQUENCY COUNTER SENSITIVITY AND TRIGGER LEVEL				
INPUT RANGE	MINIMUM SENSITIVITY (RMS SINEWAVE)		APPROXIMATE TRIGGER LEVEL (DC VOLTAGE FUNCTION)	
(Maximum input for specified accuracy = 10X Range or 1000V)	5 Hz-20 kHz	0.5 Hz-200 kHz		
400 mV dc	70 mV (to 400 Hz)	70 mV (to 400 Hz)	40 mV	
400 mV ac	150 mV	150 mV	—	
4V	0.3V	0.7V	1.7V	
40V	3V	7V	4V	
400V	30V	70V ( $\leq 140$ kHz)	40V	
1000V	300V	700V ( $\leq 14$ kHz)	400V	
Duty Cycle	0.0 to 99.9% (0.5 Hz to 200 kHz, pulse width $>2 \mu$ s)			
Accuracy:	Within $\pm(0.05\% \text{ per kHz} + 0.1\%)$ of full scale for a 5V logic family input on the 4V dc range.			
	Within $\pm(0.05\% \text{ per kHz} + 0.1\%)$ of full scale for sine wave inputs on ac voltage ranges.			

Table 1-2. Specifications, Model 87 (cont)

FUNCTION	OVERLOAD PROTECTION*	INPUT IMPEDANCE (nominal)	COMMON MODE REJECTION RATIO (1 k $\Omega$ unbalance)	NORMAL MODE REJECTION		
$\frac{mV}{mV}$	1000V rms	10 M $\Omega$ <100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz		
$\frac{mV}{V}$	1000V rms	10 M $\Omega$ <100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz		
$\frac{V}{V}$	1000V rms	10 M $\Omega$ <100 pF (ac-coupled)	>60 dB, dc to 60 Hz			
		OPEN CIRCUIT TEST VOLTAGE	FULL SCALE VOLTAGE			
		To 4.0 M $\Omega$	40 M $\Omega$ or nS	SHORT CIRCUIT CURRENT		
$\frac{mV}{A}$	1000V rms <sup>7</sup>	<1.3V dc	<450 mV dc	<1.3V dc		
Diode Test	1000V rms <sup>7</sup>	<3.9V dc	3.000V dc	1.0 mA typical		
MIN MAX Recording	NOMINAL RESPONSE	ACCURACY (5% to 100% of range)				
		100 ms to 80% (DC Functions)	Specified accuracy $\pm 12$ digits for changes $>200$ ms in duration			
	120 ms to 80% (AC Functions)	Specified accuracy $\pm 40$ digits for changes $>350$ ms and inputs $>25\%$ of range.				
	1 s	Same as specified accuracy for changes $>2$ seconds in duration				
	1 ms	Specified accuracy $\pm 40$ digits for changes $>1$ ms in duration. ( $\pm 100$ digits typical for mV, 400 $\mu$ A dc, 40 mA dc, 400 mA dc).				
FUSE PROTECTION		MAXIMUM VOLTAGE BETWEEN ANY TERMINAL AND EARTH GROUND				
mA or $\mu$ A	A	1A 600V FAST Fuse	15A 600V FAST Fuse	1000 Volts		

6 10<sup>1</sup> V/Hz max7 For circuits  $< 0.3A$  short circuit, 660V for high energy circuits

Table 1-2. Specifications, Model 87 (cont)

Display	Digital: 4000 counts, updates 4/sec 19,999 counts (4 1/2-digit mode), updates 1/sec Analog: 4 x 32 segments (equivalent to 128), updates 40/sec Frequency: 19,999 counts, updates 3/sec @ > 10 Hz Backlight: On for 68 seconds when selected.
Operating Temperature	-20°C to 55°C
Storage Temperature	-40°C to 60°C
Temperature Coefficient	0.05 x (specified accuracy)/°C (<18°C or >28°C)
Relative Humidity	0% to 90% (0°C to 35°C) 0% to 70% (35°C to 55°C)
Electromagnetic Compatibility	In an RF field of 1 V/m on all ranges and functions: Total Accuracy = Specified Accuracy + 0.5% of range. Performance above 1 V/m is not specified.
Battery Type	9V, NEDA 1604 or 6F22 or 006P
Battery Life	400 hrs typical with alkaline
Shock, Vibration	Per MIL-T-28800 for a Class 2 Instrument
Size (HxWxL)	1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)
With Holster and Flex-Stand:	2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)
Weight	12.5 oz (355g)
With Holster and Flex-Stand:	22.0 oz (624g)
Safety	Designed to Protection Class II per IEC 348, ISA-DS82, and UL1244

## Section 2

### Theory of Operation

#### 2-1. INTRODUCTION

This section describes the theory of operation for the Fluke 83, Fluke 85, and Fluke 87. Unless otherwise specified, the descriptions apply to all three instruments.

Functional block descriptions present an initial overview of circuit operation. Detailed circuit descriptions then cover the major circuit functions in more detail. For reference, detailed schematic diagrams are included in Section 5.

#### 2-2. FUNCTIONAL BLOCK DESCRIPTION

Refer to Figure 2-1 for a block diagram of the Fluke 80 Series Multimeters. The instrument is partitioned into analog and digital sections. The integrated multimeter chip (U4) performs both analog and digital functions. Also, note that the Fluke 87 incorporates additional analog circuits.

The analog section of U4 contains the a/d converter, active filter, ac converter (for Models 83 and 85), frequency-comparator, analog signal routing, range switching, and power supply functions.

The digital logic portion of U4 provides the state machine for synchronous a/d converter control and the 16-bit counter used for a/d converter counts and frequency measurements. Also, the digital logic section contains bus and interrupt control circuits (to facilitate the microcomputer interface) and registers for analog switch drive.

The microcomputer section of U4 executes software functions, formats data for the display, drives the display, and controls most analog and digital logic functions. The mode switch push buttons initiate various operating modes for the microcomputer. Output from the microcomputer can be presented visually on the liquid crystal display (LCD) and audibly on the beeper.

#### 2-3. DETAILED CIRCUIT DESCRIPTION

Each of the functional blocks in Figure 2-1 is discussed in greater detail in the following paragraphs. The schematic diagrams located at the end of this manual can be consulted for details not portrayed in the figures in this section.

#### 2-4. INPUT OVERLOAD PROTECTION

Overload protection for the  $V\Omega\text{-}\mu A$  input is provided by a network of two metal-oxide varistors (R11 and R12), three current-limiting resistors (R1, R2, and R11), and spark gap E1. The 1 kΩ, 2W fusible resistor R1 opens when an extremely high energy signal is present. Transistor R11 rises to a high impedance during a sustained voltage overload in the millivolt dc, ohm, or diode test mode. A voltage clamp network is formed by transistors Q1, Q2, and Q6, diodes CR7 and CR8, and resistor R58. During ohms and diode test overloads, this clamp circuit limits the overload current to U4 at 10 mA. Power supply regulation and system operation is maintained during any of these overloads.

Overload protection for the  $\text{mA }\mu\text{A}$  input is provided by F1, rated at 1A/600V. The  $\text{A }$  input is protected by F2, rated at 15A/600V. In addition, the micromamp shunt resistors (R4 and R43) are protected from overload currents below the F1 fusing level by the U1 and CR1 diode network.

The 83/85/87 Input-Alert feature provides a beeper warning signal when an input jack is connected to a current input and a non-current function is selected with the rotary switch. The meter detects the presence of an input connection by using split jacks at the  $\text{mA }\mu\text{A}$  and  $\text{A }$  inputs. One side of the jack is connected to an overload protection resistor (R7 for  $\text{mA }\mu\text{A}$ , R10 for  $\text{A }$ ). In turn, R7 and R10 are connected to U4 sense lines AP4 and AP5 (pins 89 and 88). Resistors R8 and R48

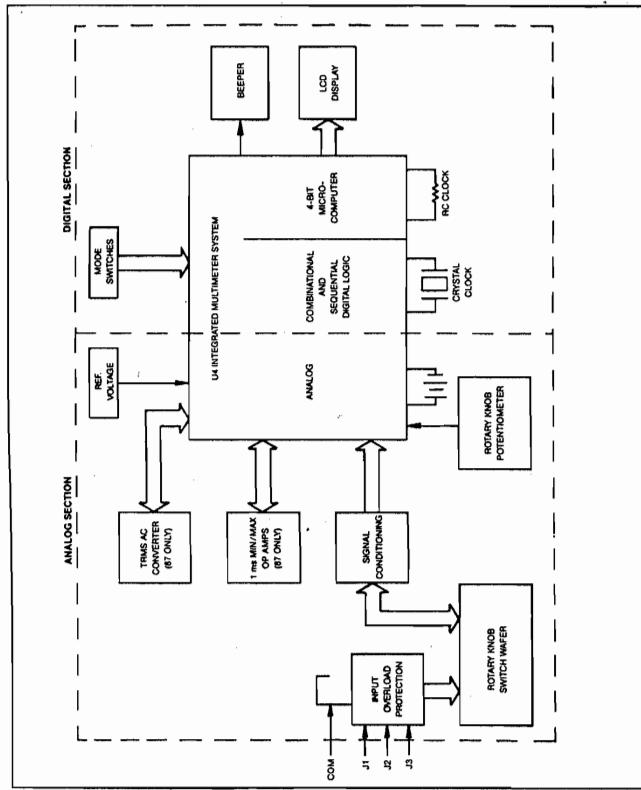


Figure 2-1. Overall Functional Block Diagram

provide Vdd pull up for AP4, and R11 is the pull up resistor for AP5. When a connection is made at mA  $\mu$ A or A, the sense side of the jack is pulled to COM. This condition is detected and compared with the selected function by U4. If a conflict exists, the beeper warning is activated.

#### 2-5. Rotary Knob Switch and Potentiometer

Input signals are routed from the overload protection circuit to a double-sided switch wafer, which provides the necessary switching to implement the various signal conditioning. The function-encoding potentiometer is attached to the associated rotary switch shaft. After turn on, or a knob position change, U4 performs a voltage ratio measurement on this potentiometer to determine the new function.

#### 2-6. Input Signal Conditioning Circuits

Each input signal is routed through signal conditioning circuitry before reaching U4. Input signals received through the  $V_{Q1-1}$  input are routed through Z1, a precision resistor network. This input divider network provides precise input scaling for the various voltage ranges and precision reference resistors for the ohms and capacitance functions. The capacitors in parallel with the various resistors in Z1 are used for high frequency compensation.

The input divider is used in two modes. In volts functions, a series mode is used to provide four divider ratios. In the ohms function, a parallel mode provides five reference resistors. During the following discussion, refer to the schematic and signal flow diagrams in Section 5.

#### 2-7. VOLTS

In Volts functions, signal flow for input divider Z1 begins with the unknown voltage at the  $V_{Q1-1}$  input, which is connected to the high end of the 9.996 M $\Omega$  resistor (pin 1 of Z1) through R1 and RT1. In AC volts, C1 is also connected in series. In DC volts, C1 is shorted by S1 (contacts 3 and 4). Internal switches connect the 9.996 M $\Omega$  and 1.1111 M $\Omega$  resistors (pin 2 to pin 3 of Z1). The low end of the 1.1111 M $\Omega$  resistor (pin 7 of Z1) is connected to COM through S1 contacts 1 and 2, producing the divide-by-10 ratio used in the 400 mV ac, 4V ac, and 4V dc ranges.

For the 40V range, internal switches connect a 10.01 k $\Omega$  resistor to provide a divide-by-100 ratio. In the 400V range, 10.01 k $\Omega$  is used for a divide-by-1000 ratio. And a 1.0001 k $\Omega$  resistor is used in the 1000V range to provide a divide-by-10000 ratio.

The internal switch resistance connecting the 1.1111 M $\Omega$  and 9.996 M $\Omega$  with the other resistors is approximately 4 k $\Omega$ . Since the A/D senses the voltage at AP1 of U4 (pin

3 of Z1), the internal switch resistance adds to the 9.996 M $\Omega$  resistor, making for a circuit total of 10 M $\Omega$ .

#### 2-8. OHMS

In the 400 ohm range the internal switches connect the 9.996 M $\Omega$  resistor (pin 2 of Z1) to the 1.0001 k $\Omega$  resistor (pin 6 of Z2); contacts 5 and 3 of S1 connect the remaining ends to these resistors, making a reference resistor of 1 k $\Omega$ . Again, the 4 k $\Omega$  internal switch resistance adds to the 9.996 M $\Omega$ .

The source voltage is connected internally at both APV4 and APV4 of U4. The current is routed through the 1.0001 k $\Omega$  and 9.996 M $\Omega$  resistors, into S1 at contacts 3 and 5, out of S1 at contact 4, through R1 and RT1, out the  $V_{Q2-1}$  input, through the unknown resistance, and back to COM. The same current flows through the unknown resistance and the reference resistor. The voltage dropped across the unknown resistance is sensed from the  $V_{Q2-1}$  input jack through R2 and S1 (contacts 11 and 12) to API of U4.

The A/D senses the voltage drop across the 1 k $\Omega$  reference resistor through the low (AP2 of U4 through R13) and high (APV0 and APV4) points. These two voltages are used by the A/D Converter to perform a ratio metric measurement.

For the 4 k $\Omega$  range, the 10.01 k $\Omega$  resistor used in parallel with the 9.996 M $\Omega$  resistor forms a 10 k $\Omega$  reference resistor. In the 40 k $\Omega$  range, 10.01 k $\Omega$  and 9.996 M $\Omega$  form a 100 k $\Omega$  reference resistor. And in the 400 k $\Omega$  range, 1.1111 M $\Omega$  and 9.996 M $\Omega$  provide a 1 M $\Omega$  reference resistor. The 4 M $\Omega$  and 40 M $\Omega$  use only the 9.996 M $\Omega$  resistor.

#### 2-9. Analog Section of Integrated Multimeter IC (U4)

The analog-to-digital converter, autorange switching, frequency comparator, and most of the remaining analog circuitry are contained in the analog section of U4. Peripherals to this U4 analog section include the crystal clock, the system reference voltage, and some filter and amplifier resistors and capacitors. Included in the U4 is only a peripheral 1 ms MIN/MAX circuit and a true rms (root-mean-square) ac-to-dc converter.

Analog-to-digital conversion is accomplished within U4 using the dual-rate, dual-slope a/d converter circuit shown in Figure 2-2. For most measurements, the basic a/d rate cycle lasts 25 ms, for 40 measurements-per-second. A single conversion at this rate is called a minor cycle sample. Each minor cycle sample is used to provide 40 updates-per-second for the fast response bar graph display, fast MIN/MAX recording, and fast autoranging.

Eight minor cycle samples are necessary to accumulate data for displaying a full-resolution (4000 count full scale)

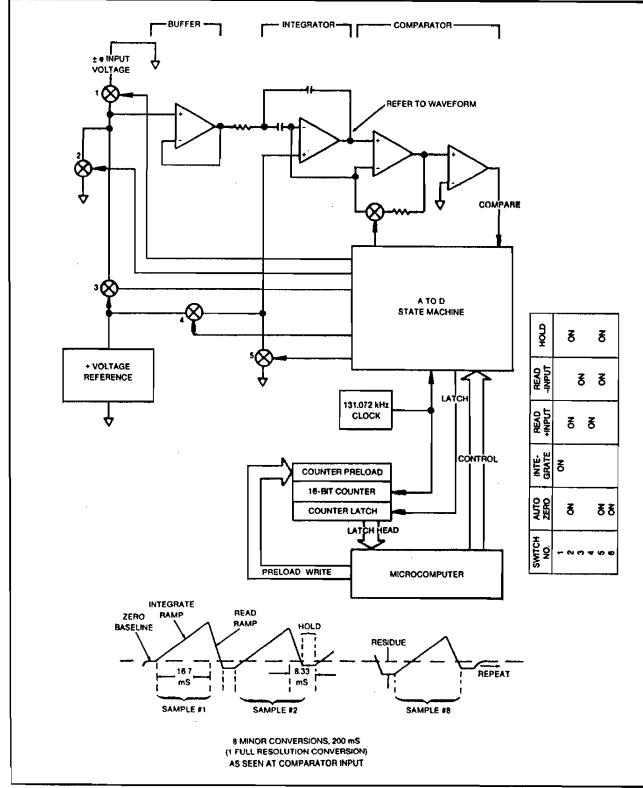


Figure 2-2. A/D Conversion

measurement on the digital display. A 40 ms autozero phase occurs following every eight-sample sequence. Therefore, each digital display update requires 240 ms, approximating 4 updates-per-second.

Basic a/d conversion elements and waveforms are illustrated in Figure 2-2. As this figure shows, a residual charge is retained by the integrator capacitor due to the overshoot past the true-zero base line. In the absence of an autozero phase, the residual charge would normally produce a significant error in the sample taken next. However, a digital algorithm eliminates the error and accounts for the residual as it propagates through all eight samples.

Basic timing for the a/d converter is defined as a series of eight integrate read cycles, followed by a 40 ms autozero phase. However, the 40 mD, capacitance, overload recovery, autoranging, Touch-Hold, 100 ms Min/Max, 1 ms Min/Max (Fluke 87 only), and rotary knob potentiometer modes all require variations from the basic timing.

Capacitance measurements to  $5.0 \mu F$  are made by measuring the charge required to change the voltage across the unknown capacitor from zero to the system reference voltage. This technique is referred to as a ballistic type of measurement, the elements of which are shown in Figure 2-3. The unknown capacitor is fully charged from zero during the a/d converter integrate cycle. The signal integrated by the a/d converter constitutes the voltage drop across one or more precision resistors ( $Z_1$ ). The reference voltage is the de-integration signal for the a/d.  $C_x$  is discharged during de-integrate, hold, and autozero. The microcomputer calculates a display value from the latched count, which is proportional to the unknown capacitance. Capacitance mode uses two samples per display update.

A voltage comparator, with microcomputer configurable offsets, is used for both signal detection in frequency and duty cycle modes and threshold detection in continuity mode. In frequency and duty cycle modes, digital pulses from the voltage comparator are routed to the 16-bit counter.

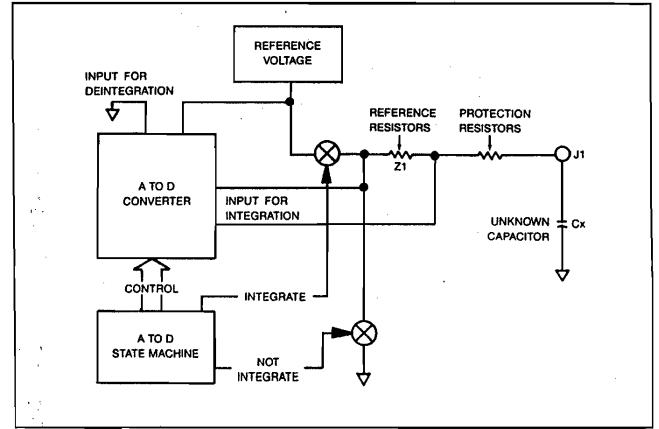


Figure 2-3. Capacitance Measurement Elements

**2-10. Digital Section of Integrated Multimeter IC (U4)**  
 Digital circuitry in U4 (excluding the microcomputer) is partitioned into five functional blocks, as shown in Figure 2-4.

- A bus control cell performs address decoding and manages selective power down, split jack sense, and low battery signals.
- The interrupt control cell manages and multiplexes four interrupts to the microcomputer. These interrupts are for 16-bit and 8-bit counter carries and voltage comparator transitions.
- A 48-bit write-only register latches microcomputer data for analog switch drive.
- A 16-bit counter (with parallel preload and latch registers) is used as a read counter for a/d conversions and as a pulse counter for frequency and duty-cycle measurements.
- The a/d converter is controlled by a 4-bit state machine with output decoding ROM.

Figure 2-5 is a block diagram of frequency counter components. For frequency and duty cycle measurements, the 16-bit counter in the digital section of U4 is partitioned into two 8-bit counters. Each of these counters is then extended to 20 bits using microcomputer software and hardware. The gating logic controls the start and stop of each reading. In frequency mode, signal A is the unknown frequency, and signal B is the crystal clock signal. After enough counts have been accumulated in each 20-bit register, the microcomputer calculates the unknown frequency from the ratio of the counter values.

In making a duty cycle measurement, signal A (Figure 2-5) is again the unknown signal, but signal B is the logical AND of the unknown and reference signals. As with frequency measurement, the microcomputer controls the start and stop of a measurement cycle via the gating logic. The ratio of the counter values yields the duty cycle value.

**2-11. Microcomputer Control**  
 A 4-bit microcomputer, integrated within U4, controls the various instrument functions and drives the display. A/D converter and counter measurements are controlled via the microcomputer interface lines shown in Figure 2-4. Min/Max, Touch-Hold, and REL (relative) modes involve additional data processing by the microcomputer to generate the display value.

The microcomputer/digital logic interface consists of both RAM that has been mapped into the digital logic and an interrupt line back to the microcomputer. The four interrupts are maskable, readable, and resettable. Note that the microcomputer runs on its own RC clock at a frequency of 525 to 800 kHz and is asynchronous from the crystal clock.

The microcomputer exercises direct control over the ranging and signal routing analog switches. A specific word is written to the switch drive register for each function/range selection. In autoranging (default) mode, the microcomputer determines the correct range based on the input. In addition, for autoranging during voltage, ohms, or current measurements, the active filter fast mode is enabled for quick response. In frequency or duty cycle mode, pushing the range button causes a range change in the primary function (volts, amps, etc.) that may change the sensitivity or offset.

The microcomputer sets the required a/d converter mode, which determines the on-chip analog signal ports to be used for the integrate and de-integrate signals. The microcomputer also selects one of the three available gain resistors in Z1 for integrate and de-integrate. All voltage and current conversions use either a 400 mV or a 40 mV full scale mode. Other modes are used for ohms, diode, 40 MΩ, N5, and capacitance. Since the a/d state machine timing is under direct software control, a mode invoked in another function or range can use different timing.

Frequency measurements are also controlled by the microcomputer section of U4. The microcomputer initializes the counters, monitors the count accumulation, arms and disarms the logic signal gating, and calculates the display value from the counter values.

Min/Max Record (1s and 100 ms), Touch-Hold, and Relative are secondary software functions. This means that the microcomputer performs either a different control algorithm or a different math routine on the data, as explained below.

- In Min/Max Record mode, the maximum and minimum readings after initialization are stored in memory, and a true running average is calculated after each reading. The running average is updated for a maximum of 36 hours. The MIN MAX button allows the user to scroll through the min, max, average, and present readings. In 100 ms Min/Max a single sample is used to calculate the display value, while in 1s Min/Max a full resolution conversion is used. Note that 1 ms Peak Min/Max (Fluke 87 only) requires additional analog peak hold amplifiers external to U4.

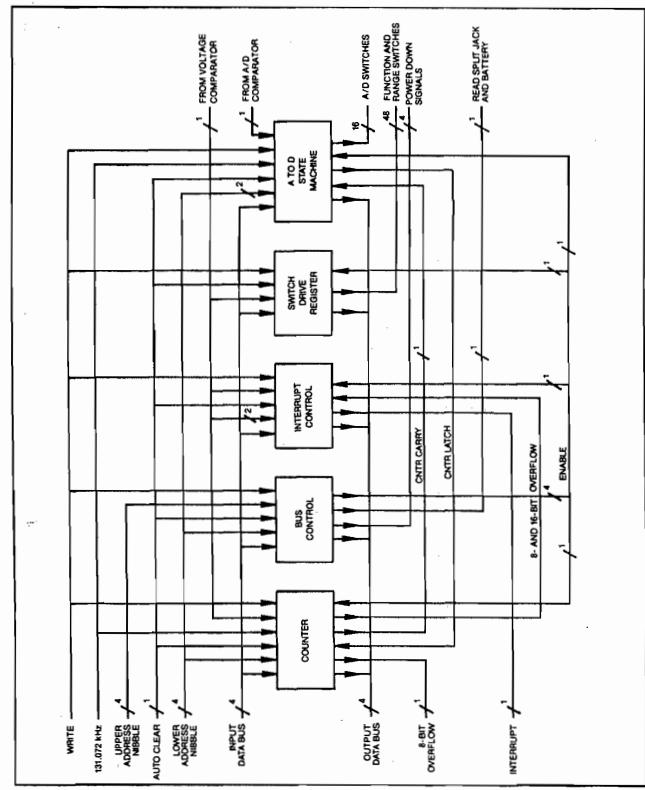


Figure 2-4. Digital Circuitry Within U4

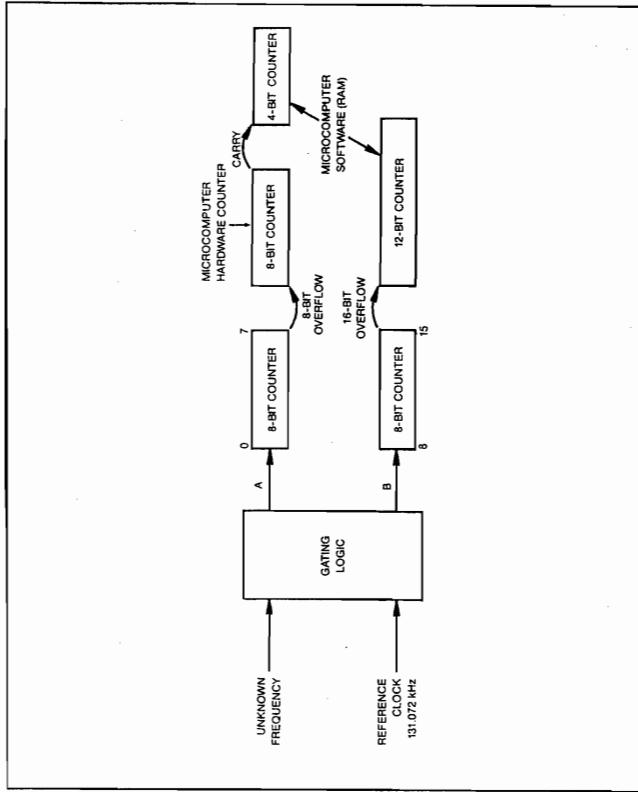


Figure 2-5. Frequency Counter Elements

- When Touch-Hold is selected, the microcomputer does not allow a full resolution conversion to be completed unless the input signal is stable. When a stable reading occurs, the conversion is completed, and the microcomputer generates and freezes the corresponding display. The microcomputer now waits for a change in the signal to exceed a certain threshold, then begins watching for a stable reading again. Note that a reading is forced when Touch Hold is first selected. Also, open test lead signals do not update the display.
- With the REL button (relative) selected, the microcomputer stores the present reading as an offset. This value is subtracted from all subsequent readings (provided that they are on scale) to give the display value.

#### 2-12. Peripherals to U4

In addition to input overload protection and input signal conditioning circuits, other devices peripheral to U4 are needed to support 80 series features. The ac converter, active filter, and a/d converter circuits require off-chip resistors and capacitors. Digital drive and level-shifting circuits are needed for the beeper drive, quick turn off, true RMS converter power down (Fluke 87 only), and LCD back light (also Fluke 87 only) features. A voltage reference is generated separate from U4, and some discrete resistors and transistors support the power supply. The Fluke 87 also uses two analog peak hold circuits (1 ms Min/Max).

#### 2-13. AC BUFFER

The ac buffer circuit differs between the Fluke 83/85 and the Fluke 87. On the Fluke 83/85, R14, R15, C5, and C27 are part of the buffer circuit that drives the ac converter and guard. The Fluke 83/85 ac buffer can be configured for an ac gain of 1 or 10. For the Fluke 87, R14, R15, R46, C5, and C27 support the ac buffer. This buffer can be configured for an ac gain of  $\frac{1}{2}$ , 1, 5, or 10. The gains of  $\frac{1}{2}$  and 5 are needed for the true rms converter, which uses a 200 mV full scale input. In the Fluke 87, the ac buffer drives the rms ac converter, guard, and peak hold amplifiers.

#### 2-14. AC CONVERTER

The Fluke 83/85 average ac converter uses off-chip components R30, R31, R34, R40, C24, C28, and C29. This ac converter is a full-wave rectifying converter with a differential output and gain selected to give a dc output equal to the rms value for a sine wave input. Filtering is provided by C28 and C29.

#### 2-15. RMS CONVERTER

The Fluke 87 uses an integrated rms-to-dc converter (U2). Devices R34, R45, C6, and C7 support U2, while Q4, R32, and R39 drive the power on/off pin.

#### 2-16. ACTIVE FILTER

On all models, the active filter uses off-chip passive components R17, R18, C8, and C9. The active filter is a second order low pass filter with two poles at 5.9 Hz in normal mode. It filters input signal noise and ac ripple from the ac converter, yielding stable a/d converter readings. The microcomputer can disable the filter completely or enable the filter fast response mode.

#### 2-17. A/D CONVERTER

Pins 9, 10 and 10 on precision resistor network Z1 connect to the three a/d converter gain resistors. Pin 8 connects to  $190\text{ k}\Omega$  for a gain of 0.87. Pin 9 connects to  $160\text{ k}\Omega$  for a gain of 1, and pin 10 connects to  $16\text{ k}\Omega$  for a gain of 10. Pin 11 is the common connection. The autozero capacitor (C10) stores op amp and comparator offsets. The integration capacitor is C11.

#### 2-18. BEEPER

Devices Q9, Q11, R56, R57 and CMOS hex inverter U6 make up the double-ended beeper drive circuit. Transistor Q12 is connected to provide quick microcomputer power down when the instrument is turned off.

#### 2-19. SYSTEM REFERENCE

The system reference voltage (1.235V) is generated by VR1 and R44. The 1.000V reference voltage for the a/d converter is supplied through U4-1 (REF1). This voltage is adjusted by R21, the dc calibration potentiometer. In addition to generating the a/d reference, the VR1 voltage is used for power supply reference, voltage comparator selectable offset generation, and the ohms source level.

#### 2-20. POWER SUPPLY

The power supply consists of two regulators, one shunt and one series, which set  $V_{dd} = +3.0\text{V}$  and  $V_{ss} = -3.2\text{V}$  for all battery/voltage down to 6.7V. The shunt (common) regulator sets  $V_{dgd} = V_{ss}$  ( $V_{dgd} = \text{COM} = 0\text{V}$ ) and consists of an uncompensated op amp and large current shunt devices integrated on U4. Resistors R37 and R38 provide voltage division. The series ( $V_{dd}$ ) regulator, which sets  $V_{dd} = V_{dgd}$ , is made up of another on-chip, uncompensated op amp, along with devices Q3, R24, and R25. Q3 is the series regulator element, and R24 and R25 are for voltage sensing. Capacitors C14 and C21 provide circuit compensation and power supply decoupling for the shunt and series regulators, respectively. Voltage level information is presented in Table 2-1.

## 80 Series Service

Table 2-1. Typical Voltage Levels and Tolerance	
VDD	3.0 $\pm 0.3$
VSS	-3.2 $\pm 0.3$
VBT+	3.5 $\pm 0.3$
VBT-	5.5 (battery at full 9V charge) 5.0 (battery at low charge of 6.5V)
REFH	1.235 $\pm 0.012$
PS0	1.235 $\pm 0.15$
PS1	0 $\pm 0.15$
AP6	-0.5 to -0.15
VOA	2.2 to 1.7 (referenced from VSS)
VOB	1.07 to .91 (referenced from VSS)

### 2-21. PEAK HOLD

The 1ms Min/Max mode on the Fluke 87 is implemented using the peak hold circuit consisting of the dual op amp package AR1, diodes CR2 and CR3, C12, C13, R22, and R23. The op amp connected to CR2 charges C12 to the most positive voltage at its input after initialization

(which can be positive or negative in amplitude.) CR2 prevents C12 from being discharged after the peak input is no longer present. The op amp connected to CR3 works in a similar fashion, but captures negative peaks. Upon selection of 1ms Min/Max, U4 initializes the circuit by connecting AP7 (pin 86) to Vss and AP8 (pin 85) to Vdd via on-chip switches. Leakage currents are controlled so that the voltages on C12 and C13 drift towards the AR1 op amp input level. The voltages stored on C12 and C13 are read, in a single sample, to give the display minimum and maximum values.

### 2-22. Display

The liquid-crystal display (LCD) operates under direct control of the microcomputer. Characters are generated by the computer and displayed on the LCD. Both digital readings and an analog bar-graph (or pointer for Fluke 87) display are presented, in conjunction with annunciators and decimal points. The Fluke 87 features a transmissive LCD with a light-emitting diode (LED) back light. Refer to the Fluke 83/85 or 87 Operator's Manual for a more detailed description of the display.



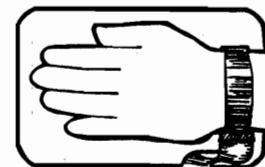
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Leaning the guidelines for handling them.
3. Using the procedures, packaging, and bench techniques that are recommended.

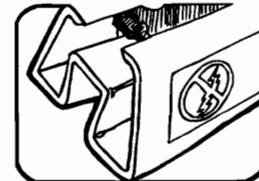
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



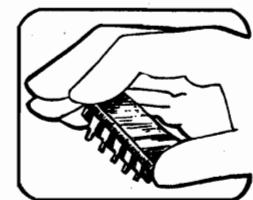
1. MINIMIZE HANDLING



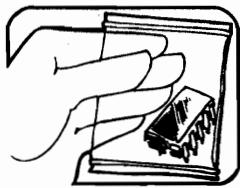
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



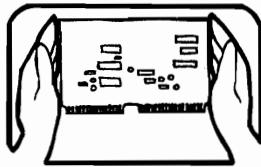
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



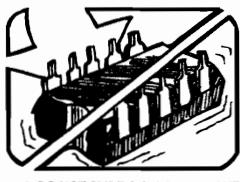
4. HANDLE S.S. DEVICES BY THE BODY.



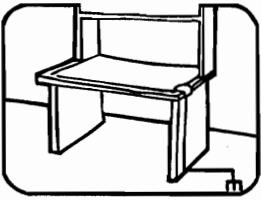
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT.



8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



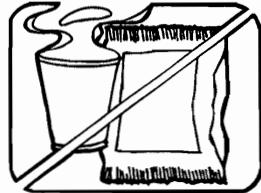
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION.

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED-TIP SOLDERING IRONS SHOULD BE USED.



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA.

PORTIONS REPRINTED  
WITH PERMISSION FROM TEKTRONIX INC.  
AND GENERAL DYNAMICS, POMONA DIV.

© Dow Chemical

## 80 Series Service

### Section 3 Maintenance

#### WARNING

SERVICING DESCRIBED IN THIS SECTION IS TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.

#### 3-1. INTRODUCTION

This section of the 80 Series Service Manual provides procedures in the following areas:

- Routine and preventive maintenance.
- Performance verifications.
- Calibration.
- Troubleshooting (to the component level.)

#### 3-2. REQUIRED TOOLS AND EQUIPMENT

Required equipment is listed in Table 3-1. If the recommended models are not available, equipment with equivalent specifications may be used. Repairs or servicing should be performed only by qualified personnel.

#### 3-3. OPERATOR MAINTENANCE

##### WARNING

TO AVOID ELECTRICAL SHOCK, REMOVE THE TEST LEADS AND ANY INPUT SIGNALS BEFORE REPLACING THE BATTERY OR FUSES. TO PREVENT DAMAGE OR INJURY, INSTALL ONLY QUICK ACTING FUSES WITH THE AMP/VOLT RATINGS SHOWN IN FIGURE 3-1.

#### 3-4. Case Disassembly

Use the following procedure to disassemble the Multimeter.

1. Disconnect test leads from any live source, turn the rotary switch to OFF, and remove the test leads from the front terminals.
2. The case rear is secured to the case front by three screws and two internal snaps (at the LCD end). Using a Phillips-head screwdriver, remove the three screws from the case rear.

##### NOTE

*The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away from the gasket easily. Do not damage the gasket or attempt to separate the lower case half from the gasket.*

3. Now turn the case over (display side up), and, lifting up on the input terminal end, disengage the upper case half from the gasket. Gently unsnap the upper case half at the display end. See Figure 3-2.

##### CAUTION

*With its case removed, the Multimeter presents exposed circuit connections. To avoid unintended circuit shorting, always place the uncovered multimeter assembly on a protective surface.*

#### 3-5. Circuit Assembly Removal and Installation

Once the outer case has been removed, the circuit assembly can be disconnected from its covering shields with the following procedure:

EQUIPMENT	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
DMM Calibrator	AC Voltage Range: 0-1000V ac Accuracy: $\pm 0.17\%$ Frequency Range: 60-20000 Hz Frequency Accuracy: $\pm 3\%$ DC Voltage Range: 0-1000V dc Accuracy: $\pm 0.03\%$ Current Range: 350 $\mu$ A-2A Accuracy: AC (60 Hz to 1 kHz): $\pm 0.3\%$ DC: $\pm 0.065\%$ Current Range: 10A Accuracy: AC (60 Hz to 1 kHz): $\pm 0.3\%$ DC: $\pm 0.1\%$ Frequency Source: 19.999 kHz - 199.99 kHz Accuracy: $\pm 0.0025\%$ Amplitude: 150 mV to 6V RMS Accuracy: $\pm 5\%$ Range: 1Ω-100 MΩ Accuracy: 0.065%	Fluke 5500A or equivalent
Resistance Calibrator	Range: 5 nF to 1 pF Accuracy: $\pm 0.35\%$ Current Range: 10A Accuracy: AC (60 Hz to 1 kHz): $\pm 0.3\%$ DC: $\pm 0.1\%$	Fluke 5450A
Decade Capacitor		Genrad 1413 or 1423
Transconductance Amplifier		Fluke 5220A

#### EQUIPMENT USAGE IN PERFORMANCE TESTS

	CALIBRATOR	RESISTANCE CALIBRATOR	DECADE CAPACITOR
AC Voltage Frequency Trigger Level DC Voltage 1-MΩ IN MAX mV DC Ohms Capacitance Diode mA $\mu$ A A	X X X X X X X X X X X X		X

## 80 Series Service

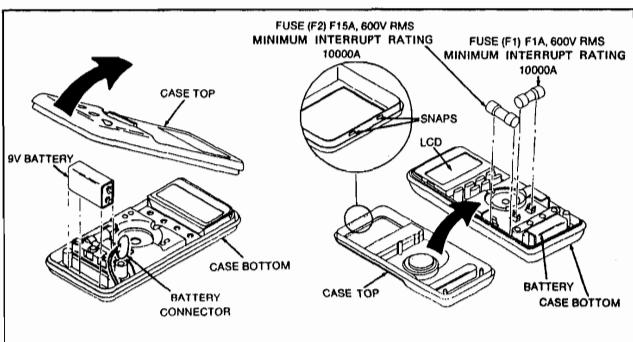


Figure 3-1. Battery and Fuse Replacement

1. Remove the one Phillips-head screw securing the back shield to the circuit assembly. Then remove the back shield.
2. The front shield can now be disconnected from the circuit assembly by detaching the four snaps (one at a time) found on the top-front.

**CAUTION**

Be gentle when detaching or attaching the four securing snaps. Excessive force can deform or fracture the snaps.

3. To reattach the circuit assembly, push the front shield on so that the four clips engage gently and simultaneously. Then turn the assembly over, and replace the Phillips-head screw and back shield.

**NOTE**

Ensure that the shields are tightly attached. Accurate multimeter operation relies on properly fitted shields.

**3-6. Case Reassembly**

Use the following procedure to reassemble the Multimeter.

## 80 Series Service

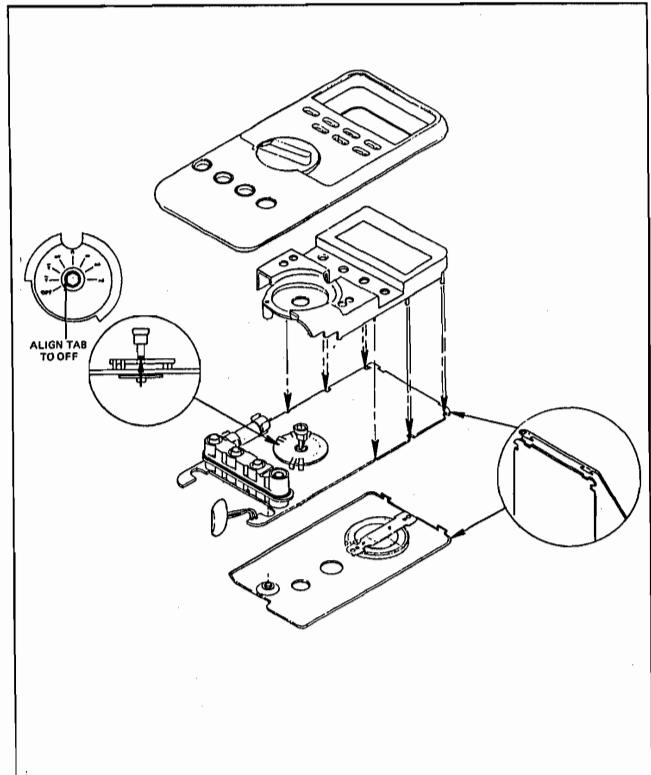


Figure 3-2. Assembly Details

4. Reassemble the Multimeter as described under Case Reassembly.

#### 3-8. Fuse Test

Use the following procedure to test the internal fuses of the meter.

1. Turn the rotary selector switch to the  $\Omega$  position.
2. Plug a test lead into the  $VΩ$  input terminal, and touch the probe to the  $[A]$  input terminal. Because the receptacles of the input terminals contain split contacts, be sure that you touch the probe to the half of the receptacle contact that is nearest the LCD.
3. The display should indicate between 0.00 and 0.05 ohms. This tests F2 (15A, 600V). If the display reads OL (overload), replace the fuse and test again. If the display reads any other value, further servicing is required.
4. Move the probe from the  $A$  input terminal to the  $mA$  input terminal.

5. The display should read between 0.995 kilohms and 1.005 kilohms. This procedure tests F1 (1A, 600V). If the display reads a high resistance or OL (overload), replace the fuse and test again. If the display reads any other value, further servicing is required.

#### 3-9. Fuse Replacement

Referring to Figure 3-1, use the following procedure to examine or replace the meter's fuses:

1. Perform steps 1 through 3 of the battery replacement procedure.
2. Remove the defective fuse by gently prying one end of the fuse loose and sliding the fuse out of the fuse bracket.
3. Install a new fuse of the same size and rating. Make sure the new fuse is centered in the fuse holder.
4. Ensure that the case top rotary switch and circuit board switch are in the OFF position.
5. Ensure that the gasket remains secured to the lower case half. Then, starting with the two snaps at the display end and finishing at the terminal end, cradle the upper case half into the gasket.
6. Reinstall the three screws from the lower case half.

#### 80 Series Service

##### 3-10. Cleaning

###### WARNING

**TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE METER, NEVER ALLOW WATER INSIDE THE CASE. TO AVOID DAMAGING THE METER'S HOUSING, NEVER APPLY SOLVENTS TO THE METER.**

If the meter requires cleaning, wipe it down with a cloth that is lightly dampened with water or a mild detergent. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol-based fluids when wiping down the meter.

##### 3-11. INPUT TERMINALS

Water, dirt, or other contamination in the  $A$  or  $mA$   $\mu A$  terminals may activate the Input Alert (beeper) feature even though test leads are not inserted. With all test leads removed, such contamination might be dislodged by turning the multimeter over and gently tapping on the case. However, the following procedure is recommended as a much more effective treatment:

1. Turn the multimeter off and remove all test leads.
2. Use a clean swab in each of the four terminals to dislodge and clean out the contamination.
3. Moisten a new swab with a cleaning and oiling agent (such as WD40). Work this swab around in each of the four terminals. Since the oiling agent insulates the terminals from moisture-related shorting, this preventive treatment ensures against future erroneous Input Alerts.

##### 3-12. ROTARY SWITCH

Clean the rotary knob potentiometer used by function selector switch S2 with the following procedure:

1. Remove the circuit assembly as described earlier in this section (Circuit Assembly Removal and Installation).
2. From the back of the circuit assembly, push the switch shaft in, and remove the polymer thick film (ptf) contact assembly.
3. Clean the ptf contact assembly and the potentiometer on the circuit assembly with alcohol. Blow these parts dry with clean, dry air.
4. Using a Q-tip, apply a thin film of W.F.Nye Gel Lubricant #8135 (Fluor. PN 92600), to the entire surface of the ptf pattern on the back side of the potentiometer. It is important that the grease be applied in a consistent manner, using only enough grease so that it does not accumulate on the ptf wiper contacts. Remove excess grease with a dry Q-tip. No portion of the ptf pattern should be left unlubricated.

3-5

#### 80 Series Service

5. Push and secure the ptf contact assembly back on the switch shaft.

6. Reassemble the circuit assembly, shields, and case parts as described earlier in the section (Case Reassembly).

7. Repeat the Performance Test after reassembly.

##### 3-13. PERFORMANCE TEST

Basic operability of an 80 Series Multimeter can be checked by turning the rotary switch to  $\Omega$  and connecting a test lead from the  $VΩ$  input to the  $mA$   $\mu A$  input. (If you are using a test probe, touch the half of the input contact nearest the LCD.) The display should read  $1.00 \pm 5$  digits. With the rotary switch still at  $\Omega$ , test the A fuse (15A) by inserting the plug end of the test lead into the  $A$  input; then test the  $mA$   $\mu A$  fuse (1A) by inserting the plug end of the test lead into the  $mA$   $\mu A$  input. The beeper emits an Input Alert if the fuses are good.

A more involved operability and accuracy check is detailed in the following paragraphs. Each function is checked for accuracy to the specifications listed in Section 1 of this manual. Note that for performance verification purposes, the case covers do not need to be removed and no adjustments are necessary. Merely make the input connections called for, and check the display for accuracy.

##### 3-14. Setup

Equipment setup is defined for each accuracy verification procedure. Equipment requirements are presented in Table 3-1. Accuracy figures are valid for a period of one year after calibration, when measured at an operating temperature of 18 to 28 degrees C and at a maximum of 90% relative humidity.

##### 3-15. Display Test

Switch the meter on and compare the display with the appropriate example in Figure 3-3. Hold any button down to hold the instrument in Display Test.

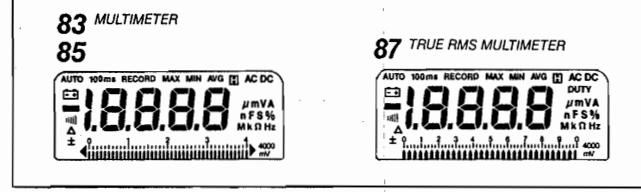


Figure 3-3. Display Test

3-6

##### 3-16. Rotary Switch Test

This test verifies correct operation of the rotary function selector switch. Internally, the selector circuit relies on the interface between a ptf region on the circuit assembly and a rotating contact assembly on the switch shaft. The rotary switch test exercises this interface by checking the various range codes and displaying their representative numbers.

To enter the rotary switch test mode, hold down the RANGE button while turning the rotary switch from OFF to  $V\Omega$ . Normal meter functions are now disabled, and a number appears in the display. Refer to Table 3-2. Continue rotating the switch one function at a time, checking for appropriate number displays. To exit the Rotary Switch mode, turn the rotary switch first to OFF, then (without holding down the RANGE button) back to any function selection.

Table 3-2. Rotary Switch Test

FUNCTION	DISPLAY ( $\pm 12$ )	FUNCTION	DISPLAY ( $\pm 12$ )
OFF	n/a	OHMS	-96
ACV	0	DIODE	-128
DCV	-32	mA/A	-160
mV DC	-64	$\mu A$	-192

##### 3-17. AC Voltage Test

Use the following procedure to verify accuracy in the ac voltage ranges.

1. Connect the Calibrator to the  $VΩ$  and COM inputs on the Multimeter.
2. Set the Calibrator for the voltage and frequency called for in step 1 of Table 3-3. Check that the multimeter display is within the limits shown for your 80 Series Multimeter (Model 83, 85, or 87).

### 80 Series Service

Table 3-3. AC Voltage Test

Step	INPUT		DISPLAY READING		
	VOLTAGE	FREQUENCY	83	85	87
1	350.0 mV	60 Hz	346.1 to 353.9	347.8 to 352.2	347.1 to 352.9
2	350.0 mV	1 kHz	344.3 to 355.7	346.1 to 353.9	346.1 to 353.9
3	350.0 mV	5 kHz	342.6 to 357.4	342.8 to 357.4	342.8 to 357.4
4	350.0 mV	20 kHz	NA	339.1 to 360.9	341.0 to 359.0
5	3.500V	60 Hz	3.462 to 3.538	3.480 to 3.520	3.473 to 3.527
6	3.500V	1 kHz	3.444 to 3.556	3.463 to 3.537	3.461 to 3.539
7	3.500V	5 kHz	3.427 to 3.573	3.428 to 3.572	3.428 to 3.574
8	3.500V	20 kHz	NA	3.350 to 3.644	3.410 to 3.590
9	35.00V	60 Hz	34.62 to 35.38	34.80 to 35.20	34.73 to 35.27
10	35.00V	1 kHz	34.44 to 35.56	34.63 to 35.37	34.61 to 35.39
11	35.00V	5 kHz	34.27 to 35.73	34.28 to 35.72	34.26 to 35.74
12	35.00V	20 kHz	NA	33.56 to 36.44	34.10 to 35.90
13	350.0V	60 Hz	346.2 to 353.8	346.0 to 352.0	347.3 to 352.7
14	350.0V	1 kHz	344.4 to 355.6	346.3 to 353.7	346.1 to 353.9
15	350.0V	5 kHz	342.7 to 357.3	342.8 to 357.2	342.6 to 357.4
16	100.0V	20 kHz	NA	95.6 to 104.4	96.0 to 104.0
17	200.0V	20 kHz	NA	191.6 to 208.4	194.0 to 206.0
18	300.0V	20 kHz	NA	287.8 to 312.4	292.0 to 308.0
19	900V	60 Hz	888 to 912	893 to 907	892 to 908
20	900V	1 kHz	874 to 926	880 to 920	887 to 913
21	900V	5 kHz	874 to 926	880 to 920	878 to 922

Table 3-4. Frequency Test

STEP	SINE WAVE INPUT		DISPLAY READING 83/85/87
	VOLTAGE	FREQUENCY	
1	150 mV rms	19.000 kHz	18.998 to 19.002
2	150 mV rms	190.00 kHz	189.98 to 190.02

3. Repeat this procedure for steps 2 through 21 of Table 3-3.

be appropriate for the specified accuracy of the Multimeter.

2. With the Multimeter in the 400 mV ac range, press the HZ button to enter the Frequency Counter mode.

3. Set the Calibrator for the sine wave voltage and frequency called for in step 1 of Table 3-4. Check for a reading within the limits shown.

**3-18. Frequency Test**  
The following procedure verifies Multimeter accuracy in Frequency mode.

1. Connect the Calibrator to the VΩ► and COM inputs on the Multimeter. Note that the frequency accuracy of the Calibrator used must

### 80 Series Service

#### 3-19. Frequency Sensitivity and Trigger Level Test

The following procedure verifies the counter sensitivity and trigger levels for all frequency modes and ranges. For any function and range, the sensitivity and trigger level is the same in both frequency and duty cycle modes.

1. Connect the meter calibrator to the VΩ► and COM inputs on the Multimeter.

2. Select the 4V ac range, and press the Hz button to choose the Frequency mode.

3. Apply the input from step 1 of Table 3-5, and check for the called-for response.

4. Select the 4V dc range, and press the Hz button to select Frequency mode.

5. Apply the input from step 2 and step 3 of Table 3-5, and check for the called-for responses.

6. On the Multimeter, press the RANGE button to enter the 40V dc range.

7. Apply the step 4 and step 5 input and check for the called-for responses on the Multimeter.

#### 3-20. DC Voltage Test

Use this procedure to verify accuracy in the dc voltage function. Note that a separate verification procedure for dc millivolts (mV) is provided later in this section.

1. Connect the Calibrator to the VΩ► and COM inputs on the Multimeter.

2. Rotate the multimeter function control to V-.

3. Check for the multimeter response called for in each step of Table 3-6.

Table 3-5. Frequency Counter Sensitivity and Trigger Level Tests

STEP	RANGE	AMPLITUDE (RMS)	FREQUENCY	DISPLAY READING
1	4V ac	300 mV ac	1 kHz	999.8 - 1000.2
2	4V dc	1.7V ac	1 kHz	999.8 - 1000.2
3	4V dc	1.0V ac	1 kHz	000.0
4	40V dc	6.0V ac	1 kHz	999.8 - 1000.2
5	40V dc	2.0V ac	1 kHz	000.0

Table 3-6. DC Voltage Test

STEP	DC INPUT VOLTAGE	DISPLAY READING		
		83	85	87
1	3.500V	3.488 to 3.512	3.495 to 3.505	3.495 to 3.505
2	35.00V	34.88 to 35.12	34.95 to 35.05	34.95 to 35.05
3	-35.00V	-34.88 to -35.12	-34.95 to -35.05	-34.95 to -35.05
4	350.0V	348.8 to 351.2	349.5 to 350.5	349.5 to 350.5
5	1000V	996 to 1004	998 to 1002	998 to 1002

**3-21. 1-MS MIN MAX Test (Model 87 only)**  
The following procedure checks the minimum/maximum hold feature of the Model 87 Multimeter.

1. Apply 2.0V ac at 60 Hz (step 1, Table 3-7) from the Calibrator to the VΩ $\text{--}$  and COM inputs of the Multimeter. Prior to entering the MIN MAX mode, rotate the function selector knob to either dc volts (for dc coupling of the input) or ac volts (for capacitive coupling of the input).

**NOTE**

The rms converter is not used in Peak mode. The digital display represents the actual peak value of the input.

2. Press the MIN MAX button to enter the Min/Max mode.
3. Press the beeper button to both enter the 1-millisecond mode and begin display of maximum values.
4. Check for the maximum reading called for in step 1 of Table 3-7.
5. Press the MIN MAX button to begin display of minimum values.
6. Check for the minimum reading called for in step 2 of Table 3-7.

**3-22. mV DC Tests**  
The following test verifies accuracy in the dc millivolt ranges.

Table 3-7. 1-MS MIN MAX Test

STEP	AC INPUT		DISPLAY READING		
	VOLTAGE	FREQUENCY	83	85	87
1	2.0V	60 Hz	n/a	n/a	2.765 to 2.890
2	2.0V	60 Hz	n/a	n/a	-2.765 to -2.890

Table 3-8. Ohms Tests

STEP	RESISTANCE	DISPLAY READING		
		83	85	87
1	190.0Ω	189.1 to 190.9	189.5 to 190.5	189.5 to 190.5
2	19.00 kΩ	18.91 to 19.09	18.95 to 19.05	18.95 to 19.05
3	1.900 MΩ	1.891 to 1.909	1.895 to 1.905	1.895 to 1.905
4	19.00 MΩ	18.78 to 19.22	18.78 to 19.22	18.78 to 19.22
5	100.0 MΩ	9.80 to 10.20	9.80 to 10.20	9.80 to 10.20

3-9

**80 Series Service**

**80 Series Service**

The following procedure verifies the capacitance measurement accuracy of your Multimeter.

1. Connect the Calibrator to the VΩ $\text{--}$  and COM inputs on the Multimeter.

2. Set the Multimeter to the mV $\text{--}$  function.

3. Apply 350.0 mV and check for the appropriate multimeter display, as follows:

Model 83	348.8 to 351.2
Model 85	349.5 to 350.5
Model 87	349.5 to 350.5

**3-23. Ohms Tests**

Use the following procedure to verify resistance measurement accuracy.

1. Connect the Resistance Calibrator to VΩ $\text{--}$  and COM on the Multimeter.

2. Rotate the multimeter function selector to Ω.

3. Check for the required display for each input called for in steps 1 through 4 of Table 3-8.

4. Press the RANGE button on the Multimeter to enter the 40-nanohm range, used for conductance tests of high resistances. Then proceed with step 5 of Table 3-8.

**3-24. Capacitance Tests**

The Multimeter measures capacitance by charging the capacitor with a known direct current, measuring the resultant voltage, and calculating the capacitance. If the same capacitance is measured on an impedance bridge, a different reading may result. This variance is likely to be greater at higher frequencies.

**3-25. Diode Test**

Use the following procedure to check the diode function:

1. Rotate the multimeter function selector to  $\text{--}$ .

2. Connect the Calibrator to the VΩ $\text{--}$  and COM inputs on the Multimeter.

**NOTE**

On Fluke 5100 series calibrators, activate the 5011 divider override.

3. Apply 3.000V, and look for a display response of  $3.000 \pm 0.061$  V dc.

**3-26. mA Tests**

The following procedure verifies accuracy of both ac and dc current measurement when the multimeter function selector is set to mA/A  $\text{--}$ .

1. Connect the Calibrator to the mA  $\mu$ A and COM inputs on the Multimeter.

2. Set the multimeter function to mA/A  $\text{--}$ .

3. Perform steps 1 and 2 in Table 3-10, checking for the appropriate multimeter display for each input.

4. Press the blue button on the Multimeter to toggle to ac current measurement.

5. Perform steps 3 through 6 in Table 3-10, checking for the appropriate multimeter display for each input.

Table 3-9. Capacitance Tests

STEP	CAPACITANCE	DISPLAY READING		
		83	85	87
1	1.0 $\mu$ F	0.96 to 1.04	0.96 to 1.04	0.96 to 1.04
2	0.470 $\mu$ F	0.462 to 0.478	0.462 to 0.478	0.462 to 0.478
3	0.0470 $\mu$ F	0.0462 to 0.0478	0.0462 to 0.0478	0.0462 to 0.0478
4	4.70 $\mu$ F	4.62 to 4.78	4.62 to 4.78	4.62 to 4.78

Table 3-10. mA Tests

STEP	DC CURRENT	DISPLAY READING		
		83	85	87
1	35.00 mA	34.84 to 35.16	34.91 to 35.09	34.91 to 35.09
2	350.0 mA	348.4 to 351.6	349.1 to 350.9	349.1 to 350.9
AC CURRENT	FREQ	DISPLAY READING		
		83	85	87
		35.00 mA	60 Hz	34.56 to 35.44
		35.00 mA	1.0 kHz	34.56 to 35.44
3	350.0 mA	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
4	350.0 mA	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
5	350.0 mA	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
6	350.0 mA	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7

3-10

### 3-27. $\mu$ A Tests

The following test verifies accuracy in the microamp ( $\mu$ A) measurement mode.

1. Connect the Calibrator to the mA  $\mu$ A and COM inputs on the Multimeter.
2. Rotate the multimeter function selector to  $\mu$ A  $\text{--}$ .
3. Verify correct display readings for the given dc inputs in steps 1 and 2 of Table 3-11.
4. Press the blue button on the Multimeter to enable ac measurements.
5. Check for the appropriate multimeter readings for steps 3 through 6 of Table 3-11.

### 3-28. A Tests

Use the following procedure to verify measurement accuracy in the ampere (A) mode.

1. If necessary, set the calibrator output to 0.
2. Rotate the multimeter function selector to mA/A  $\text{--}$ .

Table 3-11.  $\mu$ A Tests

STEP	DC CURRENT	DISPLAY READING		
		83	85	87
1	350.0 $\mu$ A	348.3 to 351.7	349.0 to 351.0	349.0 to 351.0
2	3500 $\mu$ A	3484 to 3516	3491 to 3509	3491 to 3509
	AC CURRENT	FREQ	83	85
3	3500 $\mu$ A	60 Hz	345.6 to 354.4	347.7 to 352.3
4	3500 $\mu$ A	1.0 kHz	345.6 to 354.4	347.7 to 352.3
5	3500 $\mu$ A	60 Hz	345.6 to 354.4	347.7 to 352.3
6	3500 $\mu$ A	1.0 kHz	3456 to 3544	3477 to 3523

Table 3-12. A Tests

STEP	DC CURRENT	DISPLAY READING		
		83	85	87
1	3500 mA	3484 to 3516	3491 to 3509	3491 to 3509
2	10.00A	9.94 to 10.06	9.96 to 10.04	9.96 to 10.04
	AC CURRENT	FREQ	83	85
3	3500 mA	60 Hz	3456 to 3544	3477 to 3523
4	3500 mA	1.0 kHz	3456 to 3544	3477 to 3523
5	10.00A	60 Hz	9.86 to 10.14	9.92 to 10.08
6	10.00A	1.0 kHz	9.86 to 10.14	9.92 to 10.08

### 80 Series Service

3. Connect the Calibrator to the A and COM inputs of the Multimeter.
4. Perform steps 1 and 2 in Table 3-12. For each input, check that a display appropriate for your Multimeter is obtained.
5. Set the calibrator output to 0. Now press the blue button on the Multimeter to toggle to ac current measurement once again.
6. Perform steps 3 through 6 in Table 3-12.

### 3-29. CALIBRATION

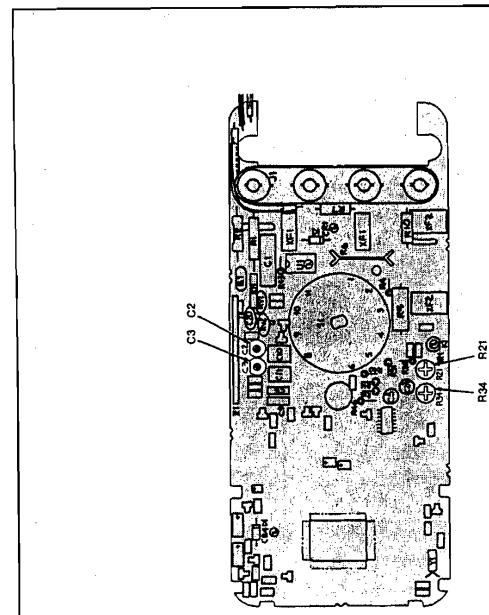
Calibrate the meter once a year to ensure that it performs according to specifications. Connect the Calibrator to the V<sub>Ω</sub>  $\text{--}$  and COM inputs on the Multimeter. Calibration adjustment points are identified in Figure 3-4. The slightly different routines required for each model of the 80 Series are presented in the following paragraphs.

### 3-30. Models 83 and 85 Calibration

Calibrate the Fluke 83 or 85 with the following procedure:

1. Set the source for VDC, 0V.
2. On the multimeter, select the V $\text{--}$  function.

### 80 Series Service



3. Connect the source to the  $V\Omega\text{-}\text{H}$  and COM inputs on the multimeter.
4. Set the source for 3.500V dc output.
5. The multimeter should now display  $3.500 \pm 0.001$ . If necessary, adjust R21 to obtain the proper display.
6. Now set the multimeter to the  $V\sim$  function, then set the source for an output of 3.500V at 100 Hz.
7. The multimeter should now display  $3.500 \pm 0.002$ . If necessary, adjust R34 to obtain the proper display.

**NOTE**

For the Fluke 85, set the source for 100V at 20 kHz. The Fluke 85 should now display  $100.0 \pm 0.2$ . If necessary, adjust C37 to obtain the proper display.

8. Set the source for an output of 3.500V at 10 kHz.
9. The multimeter should now display  $3.500 \pm 0.004$ . If necessary, adjust C2 to obtain the proper display.
10. Set the source for an output of 35.00V at 10 kHz.
11. The multimeter should now display  $35.00 \pm 0.04$ . If necessary, adjust C3 to obtain the proper display.

**3-31. Model 87 Calibration**

Calibrate the Fluke 87 with the following procedure:

1. Set the source for VDC, 0V.
2. On the Model 87, select the  $V\text{-}\text{mV}$  function.
3. Connect the source to the Model 87  $V\Omega\text{-}\text{H}$  and COM inputs.
4. Set the source for 3.500V dc output.
5. The Model 87 should now display  $3.500 \pm 0.001$ . If necessary, adjust R21 to obtain the proper display.
6. Now set the Model 87 to the  $V\sim$  function, then set the source for an output of 3.513V at 50 Hz.

**NOTE**

The disparity of 3.513 in step 6, and display of 3.500 in step 7, is due to compensation for the RMS coverter linearity.

7. The Model 87 should now display  $3.500 \pm 0.002$ . If necessary, adjust R34 to obtain the proper display.
8. Set the source for 100V at 20 kHz.

**80 Series Service**

9. The Model 87 should now display  $100.0 \pm 0.2$ . If necessary, adjust C37 to obtain the proper display.
10. Set the source for an output of 3.500V at 10 kHz.
11. The Model 87 should now display  $3.500 \pm 0.004$ . If necessary, adjust C2 to obtain the proper display.
12. Set the source for an output of 35.00V at 10 kHz.
13. The Model 87 should now display  $35.00 \pm 0.04$ . If necessary, adjust C3 to obtain the proper display.

**3-32. TROUBLESHOOTING**

If the meter fails, check the battery and fuses and replace as needed. If problems persist, verify that you are operating the meter correctly by reviewing the operating instructions found in the User's Manual. If these measures suggest a fault with the multimeter, consult the power supply troubleshooting procedures in this section and the signal flow diagrams in Section 5 of this manual.

**3-33. Servicing Surface-Mount Assemblies**

The 80 Series multimeters incorporate Surface-Mount Technology (SMT) for printed circuit assemblies (pcas). Surface-mount components are much smaller than their predecessors, with leads soldered directly to the surface of a circuit board; no plated through-holes are used. Unique soldering, troubleshooting, and repair techniques are required to support this technology. The information offered in the following paragraphs serves only as an introduction to SMT. It is not recommended that repair be attempted based only on the information presented here. Refer to the Fluke Surface Mount Device Soldering Kit for a complete demonstration and discussion of these techniques (call 1-800-526-4731 to order).

Since sockets are seldom used with SMT, shotgun troubleshooting cannot be used; a fault should be isolated to the component level before a part is replaced. Surface-mount assemblies are probed from the component side. The special probes make contact only with the pads in front of the component leads. With the close spacing involved, ordinary test probes can easily short two adjacent pins on an SMT IC.

This Service Manual is a vital source for component locations and values. With limited space on the circuit board, chip component locations are seldom labeled. Figures provided in Section 4 of this manual provide this information. Also, remember that chip components are not individually labeled; keep any new or removed component in a labeled package.

Surface-mount components are removed and replaced by refloating all the solder connections at the same time. Special considerations are required.

**80 Series Service**

Table 3-13. Functional Description of Power Supply Components

COMPONENT	FUNCTION
R24, R25	Vdd Regulator series regulator device
Q8	Power on/off device
Q10	Power supply startup device. Q10 provides Q3 base startup current. Q10 is always off during meter operation.
CR5	CR5 is in the power supply series loop, allowing for generation of $V_{b1}=3.6V$ for diode test.
VR1	VR1 provides the system reference voltage. It is used for the A/D Converter reference and as a reference for both power supply regulators.
C14	Vdd regulator compensation and bypass.
C21	Common regulator compensation and bypass.
C35	Battery and CR5 bypass.
C32	Q8 gate bypass.
R24, R25	Vdd regulator voltage sensing resistors.
R37, R38	Common regulator voltage sensing resistors.
R44	Supplies bias current to VR1.
R54	Q8 gate pull-up resistor.

- The solder tool uses regulated hot air to melt the solder; there is no direct contact between the tool and the component.
- Surface-mount assemblies require rework with wire solder rather than with solder paste. A 0.025 inch diameter wire solder composed of 63%tin and 37%lead is recommended. A 60/40 solder is also acceptable.
- A good connection with SMT requires only enough solder to make a positive metallic contact. Too much solder causes bridging, while too little solder can cause weak or open solder joints. With SMT, the anchoring effect of the through-holes is missing; solder provides the only means of mechanical fastening. Therefore, the pca must be especially clean to ensure a strong connection. An oxidized pca pad causes the solder to wick up the component lead, leaving little solder on the pad itself.

Refer to the Fluke Surface Mount Device Soldering Kit for a complete discussion of these techniques.

**3-34. TROUBLESHOOTING - POWER SUPPLY**

The two regulator circuits are interrelated; a malfunction in either the common regulator or the Vdd regulator may cause a problem in the other. Refer to Tables 3-13 and 3-14 for descriptions of power supply components and voltage levels, respectively. To isolate the problem regulator circuit, disconnect the battery, and drive  $V_{dd} - V_{ss} = 6.2V$  with a power supply. This procedure tests the common regulator independently of the Vdd regulator.

3-14

Table 3-14. Voltage Levels

VDD	$3.0 \pm 0.3$
VSS	$-3.2 \pm 0.3$
VBT+	$3.5 \pm 0.3$
VBT-	$-5.5$ (battery at full 9V charge) $-3.0$ (battery at low charge of 6.5V)
REFH	$1.235 \pm 0.012$
PSO	$1.235 \pm 0.015$
PS1	$0 \pm 0.15$
AP6	$-0.5$ to $-0.15$
VOA	2.2 to 1.7 (referenced from VSS)
VOB	1.07 to .91 (referenced from VSS)

Now check for  $V_{dgd} - V_{ss} = -3.2V \pm 0.3V$ . If this test is successful, the problem lies with the Vdd regulator; refer to Vdd Regulator Troubleshooting later in this section. If this test is not successful, the problem lies with the common regulator; continue with the Common Regulator Troubleshooting below.

Note that if the common regulator works or has been repaired, check both supplies with the 9V battery supply.

**3-35. Common (Shunt) Regulator Troubleshooting**

To troubleshoot the common regulator, connect the power supply so that  $V_{dd}$ ,  $V_{ss}$ , and  $DGND$  (digital ground) are supplied from an external power supply. This procedure over-drives the large on-chip shunt transistors; the bias current from the power supply ranges from 10 mA to 100 mA. Refer to Figure 3-5 for a simplified diagram of the common regulator. Make the following tests:

#### 80 Series Service

- Check for  $+1.235V \pm 20$  mV (Vrefh) at the cathode of VR1. If Vrefh is not correct, check VR1, R19, R20, and R44 and the traces to these parts carefully. If Vrefh is still incorrect, U4 is bad.

- If Vrefh is correct, measure the voltage at U4 pin 6 (PS1). If Vps1 is not equal to  $0V \pm 0.15V$ , check R37 and R38 and their associated traces. If Vps1 is still at an incorrect voltage, U4 is bad.

- A DGND and Vss current much larger than 100 mA may indicate a problem with Q12 (Vdgnnd-to-Vss quick turn-off clamp) or its base drive signal from U6. The Q12 clamp is off when the instrument is on and on when the instrument is off.

- Check the bias generator circuit. With the exception of resistor R35 (620 k $\Omega$ ), the bias generator (which sets the bias level for all U4 analog circuitry) is internal to U4. A problem with this circuit could cause the on-chip power supply op amps to not work. Measure the dc voltage between U4 pin 8 (Vbias) and DGND. If  $-0.2V < Vbias > +0.2V$  the bias generator is okay. If Vbias is not correct, check R35. If Vbias is still wrong, replace U4.

- Measure the ac voltage between Vdgnnd and Vss. If it is greater than 10 mV ac, check C21. (An open C21 causes common regulator instability.) The dc level may also be incorrect.

- If the common regulator still does not work, circuitry internal to U4 is bad. Replace U4.

#### 3-36. Vdd (Series) Regulator Troubleshooting

If a problem still exists after the common regulator troubleshooting, continue on with the following Vdd regulator troubleshooting. Often, a short or sneak current path causes power supply problems. Refer to Figure 3-5 for a simplified diagram of the Vdd (Series) Regulator. Make the following tests:

- Measure the dc operating current from the 9V battery. If it is greater than 1.2 mA for an 83/85 or greater than 1.4 mA for an 87, a sneak current path exists. A sneak current path can be very difficult to find.

For a final check of U4, remove the battery and supply  $Vdd = +3.0V$ ,  $Vdgnnd = 0$ , and  $Vss = -3.2V$  from an external power supply. Measure the voltage at U4 pin 7 (Vps0). If it does not equal  $1.235V \pm 0.15V$  then check R24 and R25 carefully. If Vps0 is still incorrect, U4 is bad.

#### 80 Series Service

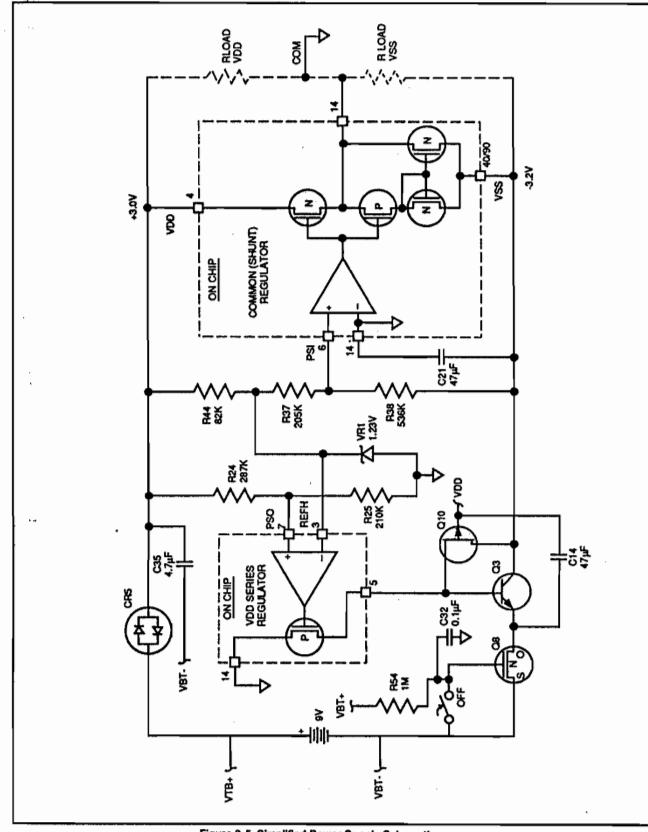
- First, visually check for both solder bridges on U4 pins and other circuit board shorts.

Isolate the current path at the negative battery terminal (Vbt-). The components connected to Vbt- are C35, CR4, R56, U6, Q8, and the rotary knob fingers. Remove these parts one at a time (except Q8). Measure I(bat) after each removal to isolate the problem.

- If the excess battery current stops after removing R56, either R56, R57, Q9, or Q11 may be bad. If one of these four parts is bad a problem may not be noticed until U6 is removed.
- If the extra current is still present with all parts except Q8 removed, remove Q10 and check for excess battery current. If I(bat) is now correct, Q10 is bad. If I(bat) is still excessive, U4 is probably at fault.

If the power supply is not working, but battery current is normal, perform the following tests.

- With the 9V battery attached, cycle the unit on and off. If both supplies are less than 1.0V, a problem probably exists with the on/off circuit. Check Q8, R54, and C32.
- Check the rotary knob wiper contacts; verify that the Q8 gate voltage is close to Vbt+.
- If  $Vdd - Vss$  is low, a problem may exist with start up device Q10. Check Q10 by momentarily connecting Vss to Vbt-. If both Vss and Vbt- now start up and operate correctly, check Q10 for an open.
- Measure the ac voltage between Vdd and Vss. An unstable Vdd regulator can be caused by an open C14. If it is greater than 10 mV ac, check C14. The dc level may also be incorrect.



## Section 4 List of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NAME	DRAWING NO.	TABLE		FIGURE	
		NO.	PAGE	NO.	PAGE
Fluke 83 Final Assembly	Fluke 83 T/B	4-1	4-4	4-1	4-5
Fluke 83 A1 Main PCA	Fluke 83-4001	4-2	4-6	4-2	4-8
Fluke 85 Final Assembly	Fluke 85 T/B	4-3	4-10	4-3	4-11
Fluke 85 A1 Main PCA	Fluke 85-4001	4-4	4-12	4-4	4-14
Fluke 87 Final Assembly	Fluke 87 T/B	4-5	4-16	4-5	4-17
Fluke 87 A1 Main PCA	Fluke 87-4001	4-6	4-18	4-6	4-20

**4-1. INTRODUCTION**

This section contains an illustrated list of replaceable parts for the 83, 85, and 87 Multimeters. Parts are listed by assembly, alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge.
- Description
- Fluke stock number
- Manufacturer's supply code
- Manufacturer's part number or generic type
- Total quantity
- Any special notes (i.e., factory-selected part)

**CAUTION**

A  symbol indicates a device that may be damaged by static discharge.

**4-2. HOW TO OBTAIN PARTS**

Electrical components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. and its authorized representatives by using the part number under the heading FLUKE STOCK NO. In the U.S., order directly from the Fluke Parts Dept. by calling 1-800-526-4731. Parts price information is available from the John Fluke Mfg. Co., Inc. or its representatives. Prices are also available in a Fluke Replacement Parts Catalog which is available on request.

In the event that the part ordered has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Fluke stock number
- Description (as given under the DESCRIPTION heading)
- Quantity
- Reference designator
- Part number and revision level of the pca containing the part.
- Instrument model and serial number

**4-3. MANUAL STATUS INFORMATION**

The Manual Status Information table that precedes the parts list defines the assembly revision levels that are documented in the manual. Revision levels are printed on the component side of each pca.

**4-4. NEWER INSTRUMENTS**

Changes and improvements made to the instrument are identified by incrementing the revision letter marked on the affected pca. These changes are documented on a supplemental change/errata sheet which, when applicable, is included with the manual.

**4-5. SERVICE CENTERS**

A list of service centers is located at the end of this section.

**NOTE **

*This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.*

**WARNING**

**THIS INSTRUMENT CONTAINS A FUSIBLE RESISTOR (PN 832550). TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.**

**MANUAL STATUS INFORMATION**

REF. DES.	ASSEMBLY NAME	FLUKE PART NO.	REVISION LEVEL
A1	Main PCA (83)	819284	T
A1	Main PCA (85)	819276	Y
A1	Main PCA (87)	819268	AD

Table 4-1. Fluke 83 Final Assembly

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFR'S SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A 3	MAIN PCA	837870	89336	817770	1	
PF 1	BATTERY, PRIMARY, ALKALINE, 9V, 0-200MA	614467	72636	MM1604	1	
E 1	CONTACT, PPF	832474	1C066	822976	1	
E 2	CONTACT, annunciator	832793	89336	823791	1	
F 1	FUSE, .062X1.375, 1A, 600V, FAST	830826	71400	886-1	1	
F 2	FUSE, .062X1.375, 1A, 600V, FAST	820829	71400	876-15	1	
E 1	SCREEN, PN, P, THD FORM, STL, 4-.14-.162	832320		COMMERCIAL	1	
E 2-4	SCREEN, PN, P, THD FORM, STL, 5-.14-.150	832346		COMMERCIAL	3	
J 1, 2	COMM, ELASTOMERIC, LCD TO PN, 1.950 L	817460	89332	817460	2	
MP 1	MASK, LCD	932384	89336	932384	1	
MP 2	SHIELD, TOP	834816	89336	834816	1	
MP 3	SHAFT, SWITCH	832618	89336	832633	1	
MP 4	SHIELD, BOTTOM	834924	89336	834924	1	
MP 5	CASE TOP (PAD ZIFER)	837266	89336	837246	1	1
MP 6	CASE & GASKET ASSY, BOTTOM	818380	89336	818380	1	
MP 7	KNOB, SWITCH (PAD ZIFER)	837273	89336	837271	1	
MP 8	SPRING, DRAFTING	832381	89336	832363	1	
MP 9	TOP, ASSY, PAD	834465	89336	834465	2	
MP 10, 11	SHOCK ABSORBER	838461	20042	838461	2	
MP 12	O-RING, AVE, NUMBER, 1.475 ID, 0.647 WIDE	831835	23160	5-1423M74-70	1	
MP 13	ROTATING PLATE ASSY (YELLOW)	833809	24406	833809	1	
MP 14	COMPONENT, BOTTOM	833820	89336	833820	1	
MP 15	COMPONENT, TOP	833767	89336	833767	1	
MP 16	TEST LEADS	833742	89336	833742	1	
MP 20	LABEL, WINDOW PLATE-PHILIPS	644337	22470	844237	1	
E 3	SWITCH PAD, MONOPART	809780	89336	809780	1	
TM 1	83/85 USER'S MANUAL (ENGLISH)	834216	89336	834216	1	
TM 2	83/85 USER'S MANUAL (INTERNATIONAL)	834226	89336	834226	1	
TM 3	83/85/87 SERVICE MANUAL	834169	89336	834169	1	
U 5	LCD, 4.5 DIGIT, BAR GRAPH, MULTIPLEXED	782762	12381	LM9393C	1	

NOTES:  
 1 Static sensitive part.  
 2 MP5 includes MP2 and MP7.

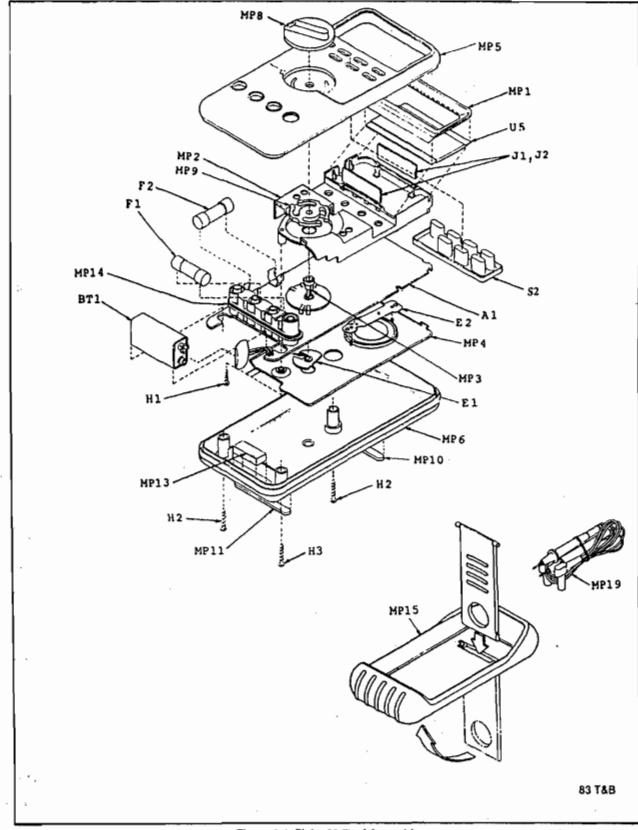


Figure 4-1. Fluke 83 Final Assembly

Table 4-2. Fluke 83 A1 Main PCA

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
C 1	CAP, POLYMER, 0.412PF, +/-10%, 100V	632341	37745	100102016100P	1	
C 2	CAP, VAR, 3.11PF, 100V, 100V	63115	37746	100102016100P	1	
C 3	CAP, VAR, 9.82PF, 100V, 100V	63130	31606	100102016100P	1	
C 4	CAP, POLY, +/-5%, 50V, C00, 1306	643348	89358	843488	1	
C 5	CAP, POLY, 0.472PF, +/-5%, 50V, C00, 1306	643349	89359	843488	1	
C 6, 9	CAP, POLY, 0.827PF, +/-10%, 50V	729779	68519	MCU1573X53B	2	
C 10	CAP, POLYMER, 0.47PF, +/-10%, 50V	697609	68519	MCU1573X53B	1	
C 11	CAP, VAR, 0.032PF, +/-10%, 50V	729779	68519	MCU1573X53B	1	
C 14, 21	CAP, VAR, 1.1PF, +/-10%, 50V	831379	68519	MCU1573X53B	1	
C 15, 14, 32	CAP, C00, 0.12PF, +/-10%, 50V	747287	64233	13048616100A0000	2	
C 17, 18	CAP, C00, 0.33PF, +/-10%, 50V, C00, 1306	740949	64233	13048613200A0000	2	
C 19	CAP, C00, 0.33PF, +/-10%, 50V, C00, 1306	740949	64233	13048613200A0000	2	
C 20	CAP, C00, 0.82PF, +/-10%, 50V, C00, 1306	681613	91984	6010C00000011, 849V14	1	
C 22	CAP, C00, 1.000PF, +/-10%, 50V, C00, 1306	747370	64233	13048610100A0000	1	
C 24	CAP, C00, 0.032PF, +/-10%, 50V	714744	84289	1304861020000000	1	
C 26	CAP, C00, 0.812PF, +/-10%, 50V, C00, 1306	714744	84289	1304861020000000	1	
C 27	CAP, C00, 1.13PF, +/-10%, 50V, C00, 1306	747261	84233	1304861030000000	4	
C 28, 29	CAP, C00, 0.33PF, +/-10%, 50V, C00, 1306	911237	94233	1304861330000000	2	
C 30	CAP, C00, 0.33PF, +/-10%, 50V, C00, 1306	911237	94233	1304861330000000	2	
C 32	CAP, VAR, 0.70F, +/-10%, 100V, 100V	867263	84289	2330478001000000	1	
C 34	CAP, VAR, 0.032PF, +/-10%, 100V, 100V	866333	64233	04090A15100A0000	1	
C 35	CAP, C00, 0.82PF, +/-10%, 100V, 100V	707979	30800	1004007	2	
C 36	CAP, C00, 0.82PF, +/-10%, 100V, 100V	707979	30800	1004007	2	
C 37	DIODE #1, 1N4001, 1A, 100V	712003	84289	2330478001000000	1	
C 38, 7, 8	DIODE #1, 1N4001, 1A, 100V, DUAL, 100V	853134	91984	04090A15100A0000	2	
C 39	DIODE #1, 1N4001, 1A, 100V, DUAL, 100V	853134	91984	04090A15100A0000	2	
J 1	INPUT RCPT ASY	842514	94091	948214	1	
J 2, 3, 4	INPUT RCPT ASY	831697	94713	949181	2	
J 5, 6, 12	TRANSFORMER, #1, 100V, 500mA, 100V	714744	84289	2330478001000000	2	
J 8	TRANSFORMER, #1, 100V, 500mA, 100V	708081	17884	2330478001000000	1	
J 10	TRANSFORMER, #1, 100V, 500mA, 100V	832477	17856	2330478001000000	1	
J 11	TRANSFORMER, #1, 100V, 500mA, 100V	714744	84289	2330478001000000	1	
J 13, 14	TRANSFORMER, #1, 100V, 500mA, 100V	912469	91936	233049	1	
R 1	RES, MP, 1K, +/-1%, 100PF, 100PF, 100PF	833860	91637	CMP-65 49 1K V-1 HOLE	1	
R 2	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	831150	93306	93306-10	1	
R 3	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	831150	93307	93307-10	1	
R 4	RES, MP, 1K, +/-1%, 100PF, 100PF	821728	99134	MP950110013P	1	
R 5	RES, MP, 1K, +/-1%, 100PF, 100PF	823448	91637	91637-10013P	1	
R 6	RES, MP, 1K, +/-1%, 100PF, 100PF	823448	91637	91637-10013P	1	
R 7, 10	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	912889	93327	90012-100M-5K	2	
R 8, 48	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	813369	91637	CRCN1306-150020	2	
R 9, 17, 29,	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	714744	84289	CRCN1306-100020	4	
R 42	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	740588	91637	CRCN1306-100020	1	
R 51	RES, C00, 1.10M, +/-1%, 1000PF, 1000PF	783174	91637	CRCN1306-100020	1	
R 52, 64-70	RES, C00, 1.10M, +/-1%, 1000PF, 1000PF	746610	91637	CRCN1306-100020	8	
R 53	RES, MP, 10K, +/-1%, 100PF, 100PF	685906	91134	91134-10000000	1	
R 55	RES, MP, 10K, +/-1%, 100PF, 100PF	685906	91134	91134-00000000	1	
R 57, 18, 43,	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	746826	91637	CRCN1306-100420	4	
R 58	RES, C00, 1.1PF, +/-1%, 100PF, 100PF	746826	91637	CRCN1306-100420	1	
R 59	RES, C00, 36.3K, +/-1%, 100PF, 100PF	833308	91637	CRCN1306-96320P	1	
R 59, 37	RES, C00, 36.3K, +/-1%, 100PF, 100PF	769538	91637	CRCN1306-20303P	2	
R 60	RES, C00, 36.3K, +/-1%, 100PF, 100PF	812161	91637	CRCN1306-20303P-2-104M	1	
R 61	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P-2-104M	1	
R 62	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 63	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 64	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 65	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 66	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 67	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 68	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 69	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 70	RES, C00, 36.3K, +/-1%, 100PF, 100PF	813363	91637	CRCN1306-20303P	1	
R 71	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 72	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 73	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 74	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 75	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 76	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 77	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 78	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 79	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 80	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 81	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 82	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 83	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 84	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 85	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 86	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 87	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 88	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 89	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 90	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 91	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 92	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 93	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 94	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 95	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 96	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 97	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 98	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 99	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 100	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 101	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 102	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 103	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 104	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 105	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 106	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 107	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 108	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 109	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 110	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 111	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 112	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 113	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 114	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 115	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 116	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 117	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 118	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 119	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 120	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 121	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 122	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 123	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000	1	
R 124	RES, C00, 36.3K, +/-1%, 100PF, 100PF	712003	84289	2330478001000000</		

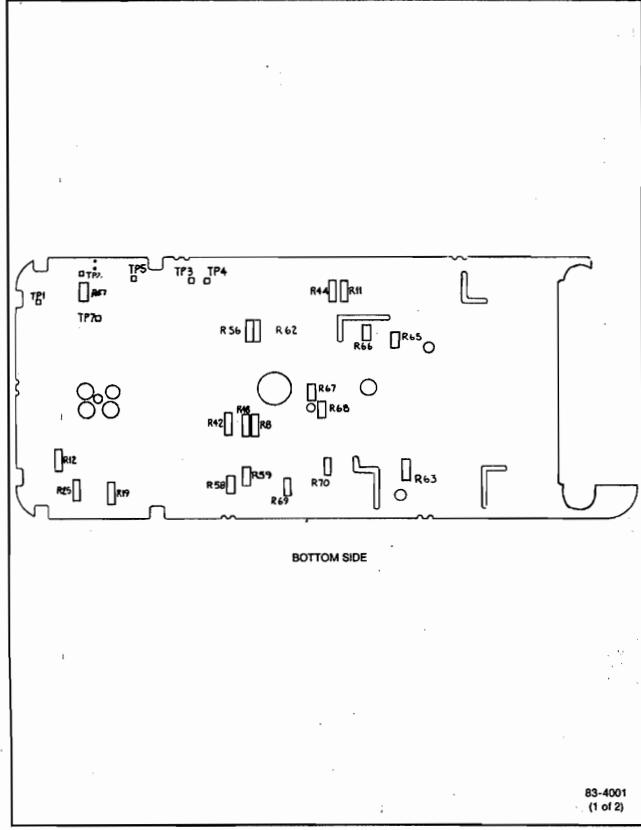


Figure 4-2. Fluke 83 A1 Main PCA

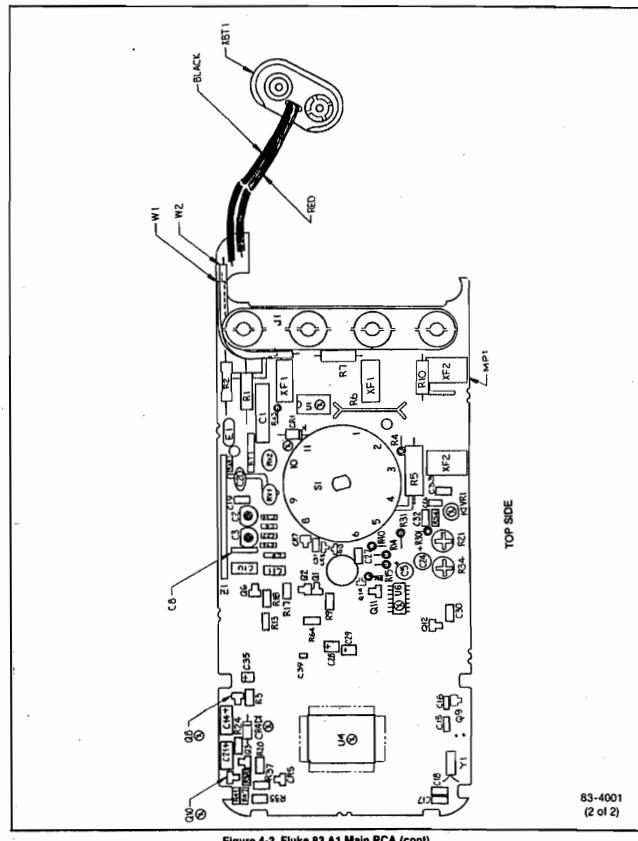


Figure 4-2. Fluke 83 A1 Main PCA (cont)

Table 4-3. Fluke 85 Final Assembly

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFNS BPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A 1	MAIN PCA	897987	89936	857667	1	
BT 1	BATTERY, PRIMARY, ALKALINE, 9V, 0-200MA	614497	72634	9M1604	1	
BT 2	CONNECTOR, F/F	614498	72635	922676	1	
F 1	FUSE, 4.0X11.375, 1A, 600V, PART	623795	00383	8227871	3	
F 2	FUSE, 4.0X11.375, 1A, 600V, PART	620828	71660	8227860	1	
F 3	FUSE, 4.0X11.375, 1A, 600V, PART	620839	71400	8227815	1	
H 1	SCREW, PH.3, TWD FORM, PTU, 5-14, .563	893335	71400	COMMERCIAL	1	
H 2- 4	SCREW, PH.3, TWD FORM, PTU, 5-14, .750	893346	71400	COMMERCIAL	2	
J 1, 2	CONN, ELASTOMERIC, LCD TO FWR, 1.1992 L	617446	00382	857446	2	
MP 1	MARK, LCD	930374	89936	930274	1	
MP 2	SWTLD, TOP	624516	89936	924516	1	
MP 3	SWTLD, SWITCH	623493	89936	922416	1	
MP 4	SWTLD, BOTTOM	624524	89936	924524	1	
MP 5	CASE TOP (PAD XFRS)	897268	89936	897268	1	
MP 6	CASE & GASKET ASMB, BOTTOM	819290	89936	932280	1	
MP 7	KNOB, SWITCH (PAD XFRS)	897273	89936	937273	1	
MP 8	SPRING, DENTED	623443	89936	932443	1	
MP 10, 11	FOOT, NON SKID	824464	30043	824464	2	
MP 12	SHOCK ABSORBER	828451	30043	828451	1	
MP 14	O-RING, STM NUMBER, 1.470 ID, 0.047 WIDE	831933	28160	8-1426474-70	1	
MP 15	HOLSTER/ALARMSTND ASMB (YELLOW)	832809	38460	822809	1	
MP 16	CONTAINER, BOTTOM	832839	89936	822829	1	
MP 17	CONTAINER, TOP	832775	89936	822775	1	
MP 18	TERM, LEADS	868743	89936	887743	1	
MP 20	LARGE WINDOW FLUKE-PHILLIPS	864337	23670	844337	1	
S 2	SWITCH PAD, MONITORARY	809988	89936	809988	1	
TM 1	81/82 USER'S MANUAL (ENGLISH)	834219	89936	834219	1	
TM 2	81/82 USER'S MANUAL (INTERNATIONAL)	834326	89936	834326	1	
TM 3	81/82/83 SERVICE MANUAL	834169	89936	834169	1	
U 1	LCD, 4.5 DIGIT, 80MM, GRAPH, MULTIPLEXED	782743	123861	Le293C	1	

NOTES:  
 1. Static sensitive part.  
 2. MP5 included MP7 and MP8.

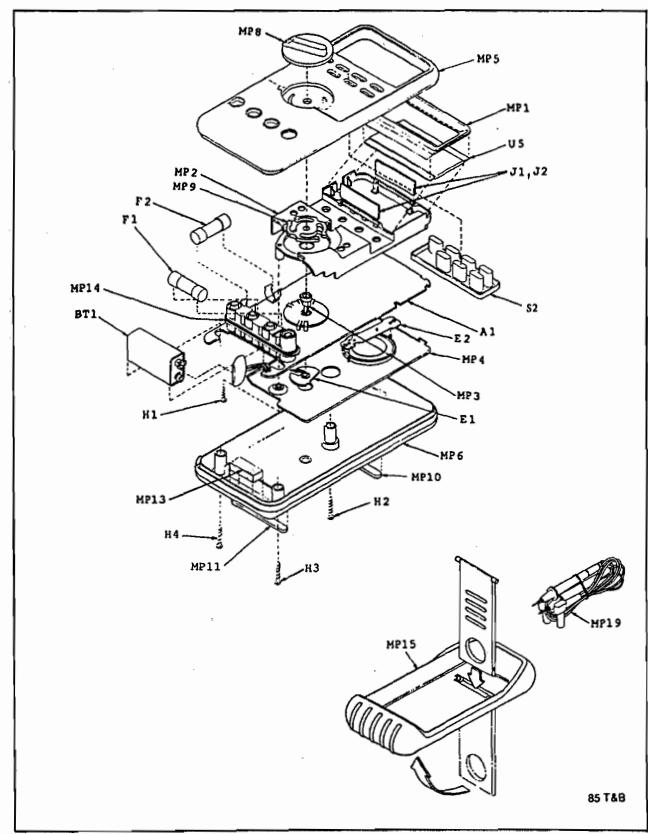


Figure 4-3. Fluke 85 Final Assembly

Table 4-4. Fluke 85 A1 Main PCA

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
C 1	CAP, POLYMER, 0.25PF, -10%, 1000V	823121	27912	10010321000PF	1	
C 2	CAP, VAR, 3-13PF, 100V	843713	21606	W030312001214	1	
C 3	CAP, VAR, 0.0002PF, 0.001%, 100V, COG, 1206	843130	21606	W0303090921214	1	
C 4	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	843173	89314	W0303090921206	1	
C 5	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	843174	89314	W0303090921206	1	
C 6, 9	CAP, POLYMER, 0.23PF, -10%, 63V	729977	89319	MCG12728232	2	
C 10	CAP, POLYMER, 0.47PF, -10%, 50V	697409	89319	MCG12748232	1	
C 11	CAP, VAR, 0.0002PF, 0.001%, 100V, COG, 1206	823122	27912	10010321000PF	1	
C 14, 25	CAP, VAR, 0.0002PF, 0.001%, 100V, COG, 1206	823123	27912	10010321000PF	1	
C 15, 16, 33	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	747387	04323	13064510404X000	3	
C 17, 18, 19	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	740983	04323	13064523200X000R	3	
C 20	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	843175	89314	W0303090921206	1	
C 21	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	843176	89314	W0303090921206	1	
C 22	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	843348	89316	W0303090921206	1	
C 23	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	823144	27914	10010321000PF	1	
C 24	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	729978	89319	MCG12728232	1	
C 25, 31, 33,	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	747381	04323	1306451030X000	4	
C 26	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	747382	04323	1306452310X000	1	
C 28, 29	CAP, VAR, 0.47PF, -10%, 25V, 8226	823109	89319	3320474280230297	2	
C 30	CAP, CER, 0.33PF, -10%, 50V, COG, 1206	780907	04323	1306452310X000	1	
C 31	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	823108	27912	10010321000PF	1	
C 34	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	823107	27912	10010321000PF	1	
C 35	CAP, CER, 0.0002PF, -10%, 100V, COG, 1206	823108	27912	10010321000PF	1	
C 37	CAP, VAR, 0.33PF, -10%, 50V, 8226	747384	04323	1306452300X000	1	
C 38	CAP, CER, 0.0002PF, -10%, 100V, COG, 0005	846553	04323	13064523520X000R	1	
C 39	CAP, CER, 0.0002PF, -10%, 100V, COG, 0005	747385	04323	13064523520X000R	1	
CR 1, 7, 8	DIODE, 81-0078, 0V-10mA, 100V, 0.0023	743339	04323	NAV92	3	
S 1	SURFACE PROTECTOR, 1500V, -25%	689134	81984	10071	1	
S 2	SURFACE PROTECTOR, 1500V, -25%	689135	81984	10071	1	
S 3, 4	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	821657	04713	130645103801	2	
S 3, 9, 13	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743076	04713	13064500404	2	
S 10	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	821658	04713	13064500404	1	
S 11	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	821659	04713	13064500404	1	
S 12, 14	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743077	04713	13064500404	1	
S 13	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743078	04713	13064500404	1	
S 14	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743079	04713	13064500404	1	
S 15	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743080	04713	13064500404	1	
S 16	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743081	04713	13064500404	1	
S 17	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743082	04713	13064500404	1	
S 18	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743083	04713	13064500404	1	
S 19	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743084	04713	13064500404	1	
S 20	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743085	04713	13064500404	1	
S 21	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743086	04713	13064500404	1	
S 22	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743087	04713	13064500404	1	
S 23	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743088	04713	13064500404	1	
S 24	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743089	04713	13064500404	1	
S 25	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743090	04713	13064500404	1	
S 26	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743091	04713	13064500404	1	
S 27	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743092	04713	13064500404	1	
S 28	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743093	04713	13064500404	1	
S 29	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743094	04713	13064500404	1	
S 30	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743095	04713	13064500404	1	
S 31	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743096	04713	13064500404	1	
S 32	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743097	04713	13064500404	1	
S 33	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743098	04713	13064500404	1	
S 34	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743099	04713	13064500404	1	
S 35	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743100	04713	13064500404	1	
S 36	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743101	04713	13064500404	1	
S 37	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743102	04713	13064500404	1	
S 38	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743103	04713	13064500404	1	
S 39	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743104	04713	13064500404	1	
S 40	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743105	04713	13064500404	1	
S 41	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743106	04713	13064500404	1	
S 42	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743107	04713	13064500404	1	
S 43	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743108	04713	13064500404	1	
S 44	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743109	04713	13064500404	1	
S 45	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743110	04713	13064500404	1	
S 46	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743111	04713	13064500404	1	
S 47	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743112	04713	13064500404	1	
S 48	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743113	04713	13064500404	1	
S 49	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743114	04713	13064500404	1	
S 50	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743115	04713	13064500404	1	
S 51	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743116	04713	13064500404	1	
S 52	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743117	04713	13064500404	1	
S 53	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743118	04713	13064500404	1	
S 54	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743119	04713	13064500404	1	
S 55	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743120	04713	13064500404	1	
S 56	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743121	04713	13064500404	1	
S 57	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743122	04713	13064500404	1	
S 58	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743123	04713	13064500404	1	
S 59	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743124	04713	13064500404	1	
S 60	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743125	04713	13064500404	1	
S 61	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743126	04713	13064500404	1	
S 62	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743127	04713	13064500404	1	
S 63	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743128	04713	13064500404	1	
S 64	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743129	04713	13064500404	1	
S 65	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743130	04713	13064500404	1	
S 66	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743131	04713	13064500404	1	
S 67	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743132	04713	13064500404	1	
S 68	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743133	04713	13064500404	1	
S 69	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743134	04713	13064500404	1	
S 70	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743135	04713	13064500404	1	
S 71	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743136	04713	13064500404	1	
S 72	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743137	04713	13064500404	1	
S 73	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743138	04713	13064500404	1	
S 74	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743139	04713	13064500404	1	
S 75	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743140	04713	13064500404	1	
S 76	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743141	04713	13064500404	1	
S 77	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743142	04713	13064500404	1	
S 78	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743143	04713	13064500404	1	
S 79	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743144	04713	13064500404	1	
S 80	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743145	04713	13064500404	1	
S 81	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743146	04713	13064500404	1	
S 82	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743147	04713	13064500404	1	
S 83	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743148	04713	13064500404	1	
S 84	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743149	04713	13064500404	1	
S 85	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743150	04713	13064500404	1	
S 86	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743151	04713	13064500404	1	
S 87	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743152	04713	13064500404	1	
S 88	VALVE/PISTON, 81-0078, 0V-10mA, 100V, 0.0023	743153	04			

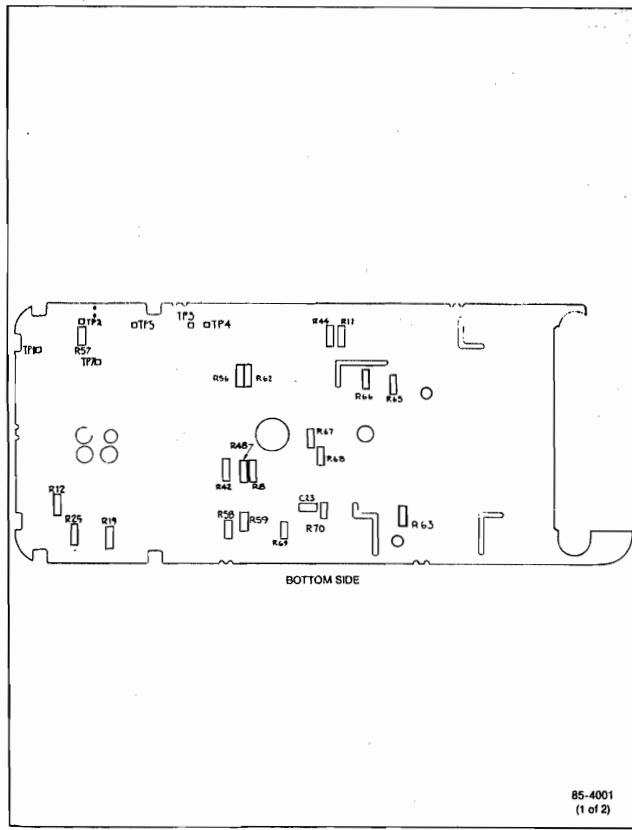


Figure 4-4. Fluke 85 A1 Main PCA

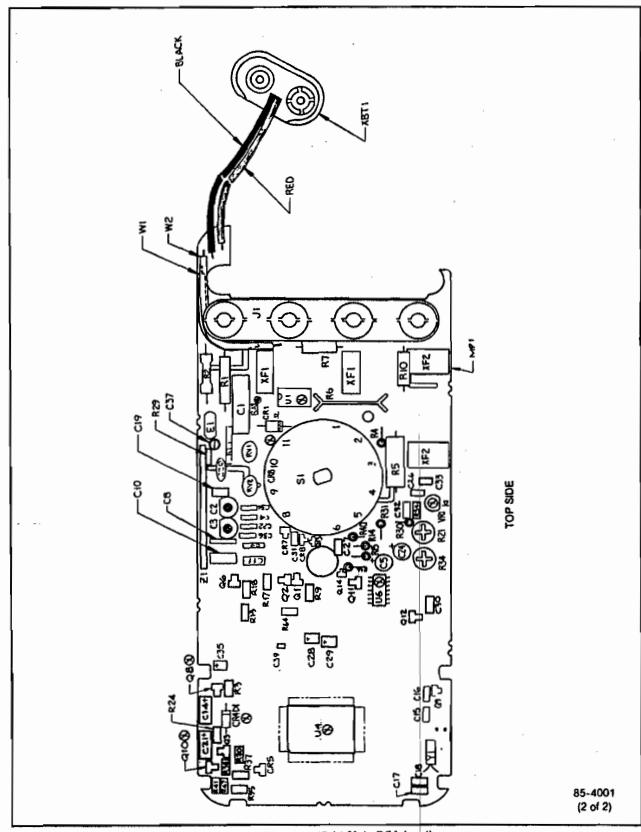


Figure 4-4. Fluke 85 A1 Main PCA (cont)

Table 4-5. Fluke 87 Final Assembly

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A 1	MAIN PCA	857862	855310	857862	1	
BT 1	BATTERY, PRIMARY, ALKALINE, 9V, 0-300mA	614457	725316	W01404	1	
CA 4	BACKLIGHT	818342	3W010	815743	1	
E 1	CONTACT, PTF	823676	100466	822676	1	
E 2	CONTACT, ANNIHILATOR	923791	083820	823791	1	
F 1	FUSE, .04X21.5, 1SA, 600V, FAST	820639	71400	857158	1	
F 2	FUSE, .04X21.5, 1SA, 600V, FAST	820639	71400	857158	1	
H 1	SCREW, PH. P, TWO FORM, STL, 4-14, .642	823230		COMMERCIAL	1	
H 2 - 4	SCREW, PH. P, TWO FORM, STL, 4-14, .780	823244		COMMERCIAL	3	
J 1, 2	COMM, SLIDEWHEEIC, LCD TO PWB, 1.590 L	817460	083820	817460	2	
MP 1	MARK, LCD	930271	89530	8150371	1	
MP 2	SHIELD, TOP	824515	89530	824515	1	
MP 3	SWIFT, SWITCH	823433	89530	823433	1	
MP 4	SHIELD, BOTTOM	824514	89530	824524	1	
MP 5	CASE, 4.5 DIGIT (PAD SPKA)	823459	89530	823459	1	
MP 6	CASE, 4.5 DIGIT (PAD SPKA), BOTTOM	823459	89530	823459	1	
MP 7	DOOR, SWITCH (PAD SPKA)	927272	89530	857272	1	
MP 8	SPRING, DOME	823453	89530	823453	1	
MP 9	FOOT, HIGH ACCD	824456	20040	824456	2	
MP 10, 11	SWING ABSORBER	829511	20040	829511	2	
MP 12	O-RING, 9V BURNER, 1.670 ID, 0.047 WIDE	831593	20160	831593-10	1	
MP 13	MOLYBRAZEDLEAD ASSY (YELLOW)	823343	28400	823343	3	
MP 14	COMPATIM, BOTTOM	822035	89530	822035	1	
MP 15	COMPATIM, TOP	822017	89530	822017	1	
MP 16	TEST LEADS	85742	89530	855742	1	
MP 17	LABEL, WINDOW FLICKER-PHILIPS	844357	23470	844337	1	
MP 18	SWITCH PAD, MONITORARY	809570	89530	809570	1	
E 3	87 USER'S MANUAL (ENGLISH)	824192	89530	834192	1	
VM 1	87 USER'S MANUAL (INTERNATIONAL)	834200	89530	834200	1	
VM 2	83, 85, 87 SERVICE MANUAL	834168	89530	834168	1	
VM 3	LCD, 4.5 DIGIT, BAR GRAPH, MULTIPLEXED	832188	12381	828748	1	
NOTES:						
1 Static sensitive part.						
2 MP5 includes MP6 and MP9.						

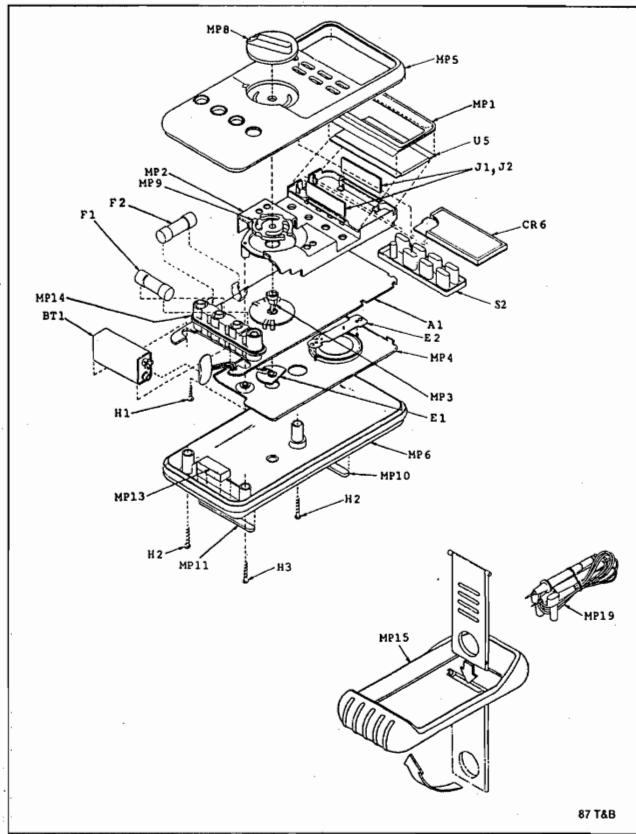


Figure 4-5. Fluke 87 Final Assembly

Table 4-6. Fluke 87 A1 Main PCA

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A1	IC, OP AMP, DUAL, FIX NED POWER, 802C	930810		FLC2732812M	1	
C 1	CAP, VAR, 0.1-100PF, -10%, 100V	822361		73742	1	
C 2	CAP, VAR, 0.1-100PF, -10%, 100V	822362		164010X10000F	1	
C 3	CAP, VAR, 0.2-20PF, 50V, CCR	843129		768011050PR174	1	
C 4	CAP, CCR, 640PF, -3%, 100V, COG, 1206	843130		1880114420000002	1	
C 5	CAP, CCR, 12PF, -10%, 100V	843131		1880114420000003	1	
C 6	CAP, CCR, 12PF, -10%, 100V	843132		1880114420000004	1	
C 7	CAP, CCR, 12PF, -10%, 100V	714662		56391	1	
C 8, 9	CAP, POLYCAP, 0.1-100PF, -10%, 100V	702079		WKC3773XH329	2	
C 10	CAP, POLYCAP, 0.1-100PF, -10%, 100V	843133		WKC3773XH329	1	
C 11	CAP, POLYCAP, 0.2-20PF, -10%, 100V	843134		WKC3773XH329	1	
C 12, 13	CAP, POLYCAP, 0.6-60PF, -10%, 100V	843135		WKC3773XH329	2	
C 14	CAP, CCR, 0.1-10PF, -10%, 100V	747897		1880114420000005	1	
C 15, 16, 33	CAP, CCR, 0.1-10PF, -10%, 100V, ZT8, 1206	747898		1880114420000006	3	
C 17, 18, 19	CAP, CCR, 0.2-20PF, -10%, 100V, COG, 1206	747899		1880114420000007	3	
C 19	CAP, CCR, 0.2-20PF, -10%, 100V, COG, 1206	747900		1880114420000008	1	
C 20	CAP, CCR, 0.2-20PF, -10%, 100V, COG, 1206	747901		1880114420000009	1	
C 21	CAP, CCR, 0.7-70PF, -5%, 100V, ZT8, 1206	942662		942365	1	
C 22	CAP, CCR, 0.7-70PF, -5%, 100V, ZT8, 1206	942663		942365	1	
C 23	CAP, CCR, 0.7-70PF, -5%, 100V	939364		939364	1	
C 24	CAP, CCR, 0.7-70PF, -5%, 100V, ZT8, 1206	747861		1880114420000010	1	
C 25	CAP, CCR, 1.0-10PF, -10%, 100V, COG, 1206	740871		188011441010000000	1	
C 26	CAP, CCR, 1.0-10PF, -10%, 100V, COG, 1206	740872		188011441010000001	1	
C 27	CAP, CCR, 1.0-10PF, -10%, 100V, COG, 1206	740873		188011441010000002	1	
C 28	CAP, ZT8, 4.7-47PF, -10%, 100V, ZT8	876823		188011442000000000	1	
C 29	CAP, ZT8, 4.7-47PF, -10%, 100V, ZT8	876824		188011442000000001	1	
C 30	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876868		188011442000000002	1	
C 31	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876869		188011442000000003	1	
C 32	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876870		188011442000000004	1	
C 33	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876871		188011442000000005	1	
C 34	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876872		188011442000000006	1	
C 35	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876873		188011442000000007	1	
C 36	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876874		188011442000000008	1	
C 37	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876875		188011442000000009	1	
C 38	CAP, CCR, 100PF, -1%, 100V, COG, 1206	876876		188011442000000010	1	
CR 1, 4	DIODE, 1N4148, 1N4148, 1N4148, 1N4148	742011		W3H-53-017	1	
CR 2, 3	DIODE, 1N4148, 1N4148, 1N4148, 1N4148	742012		W3H-53-017	1	
CR 4, 7, 8	DIODE, 1N4148, 1N4148, 1N4148, 1N4148	742013		W3H-53-017	2	
J 1	IC, OP AMP, DUAL, FIX NED POWER, 802C	747862		18801144200000011	1	
J 2	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822363		WKC3773XH329	1	
J 3	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822364		WKC3773XH329	1	
J 4	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822365		WKC3773XH329	1	
J 5	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822366		WKC3773XH329	1	
J 6	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822367		WKC3773XH329	1	
J 7	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822368		WKC3773XH329	1	
J 8	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822369		WKC3773XH329	1	
J 9	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822370		WKC3773XH329	1	
J 10	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822371		WKC3773XH329	1	
J 11	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822372		WKC3773XH329	1	
J 12	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822373		WKC3773XH329	1	
J 13	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822374		WKC3773XH329	1	
J 14	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822375		WKC3773XH329	1	
J 15	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822376		WKC3773XH329	1	
J 16	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822377		WKC3773XH329	1	
J 17	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822378		WKC3773XH329	1	
J 18	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822379		WKC3773XH329	1	
J 19	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822380		WKC3773XH329	1	
J 20	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822381		WKC3773XH329	1	
J 21	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822382		WKC3773XH329	1	
J 22	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822383		WKC3773XH329	1	
J 23	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822384		WKC3773XH329	1	
J 24	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822385		WKC3773XH329	1	
J 25	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822386		WKC3773XH329	1	
J 26	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822387		WKC3773XH329	1	
J 27	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822388		WKC3773XH329	1	
J 28	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822389		WKC3773XH329	1	
J 29	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822390		WKC3773XH329	1	
J 30	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822391		WKC3773XH329	1	
J 31	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822392		WKC3773XH329	1	
J 32	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822393		WKC3773XH329	1	
J 33	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822394		WKC3773XH329	1	
J 34	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822395		WKC3773XH329	1	
J 35	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822396		WKC3773XH329	1	
J 36	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822397		WKC3773XH329	1	
J 37	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822398		WKC3773XH329	1	
J 38	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822399		WKC3773XH329	1	
J 39	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822400		WKC3773XH329	1	
J 40	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822401		WKC3773XH329	1	
J 41	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822402		WKC3773XH329	1	
J 42	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822403		WKC3773XH329	1	
J 43	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822404		WKC3773XH329	1	
J 44	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822405		WKC3773XH329	1	
J 45	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822406		WKC3773XH329	1	
J 46	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822407		WKC3773XH329	1	
J 47	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822408		WKC3773XH329	1	
J 48	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822409		WKC3773XH329	1	
J 49	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822410		WKC3773XH329	1	
J 50	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822411		WKC3773XH329	1	
J 51	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822412		WKC3773XH329	1	
J 52	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822413		WKC3773XH329	1	
J 53	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822414		WKC3773XH329	1	
J 54	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822415		WKC3773XH329	1	
J 55	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822416		WKC3773XH329	1	
J 56	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822417		WKC3773XH329	1	
J 57	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822418		WKC3773XH329	1	
J 58	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822419		WKC3773XH329	1	
J 59	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822420		WKC3773XH329	1	
J 60	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822421		WKC3773XH329	1	
J 61	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822422		WKC3773XH329	1	
J 62	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822423		WKC3773XH329	1	
J 63	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822424		WKC3773XH329	1	
J 64	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822425		WKC3773XH329	1	
J 65	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822426		WKC3773XH329	1	
J 66	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822427		WKC3773XH329	1	
J 67	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822428		WKC3773XH329	1	
J 68	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822429		WKC3773XH329	1	
J 69	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822430		WKC3773XH329	1	
J 70	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822431		WKC3773XH329	1	
J 71	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822432		WKC3773XH329	1	
J 72	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822433		WKC3773XH329	1	
J 73	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822434		WKC3773XH329	1	
J 74	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822435		WKC3773XH329	1	
J 75	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822436		WKC3773XH329	1	
J 76	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822437		WKC3773XH329	1	
J 77	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822438		WKC3773XH329	1	
J 78	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822439		WKC3773XH329	1	
J 79	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822440		WKC3773XH329	1	
J 80	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822441		WKC3773XH329	1	
J 81	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822442		WKC3773XH329	1	
J 82	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822443		WKC3773XH329	1	
J 83	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822444		WKC3773XH329	1	
J 84	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822445		WKC3773XH329	1	
J 85	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822446		WKC3773XH329	1	
J 86	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822447		WKC3773XH329	1	
J 87	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822448		WKC3773XH329	1	
J 88	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822449		WKC3773XH329	1	
J 89	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822450		WKC3773XH329	1	
J 90	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822451		WKC3773XH329	1	
J 91	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822452		WKC3773XH329	1	
J 92	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822453		WKC3773XH329	1	
J 93	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822454		WKC3773XH329	1	
J 94	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822455		WKC3773XH329	1	
J 95	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822456		WKC3773XH329	1	
J 96	IC, OPAMP, 1000V, 1000V, 1000V, 1000V	822457		WKC3773XH329	1	
J 97	IC, OPAMP, 1					

Table 4-6. Fluke 87 A1 Main PCA (cont)

REF DESIGNATOR XP 1 is two (2) parts. They are used with P1 on the Final Assembly.  
 REF DESIGNATOR XP 2 is two (2) parts. They are used with P2 on the Final Assembly.

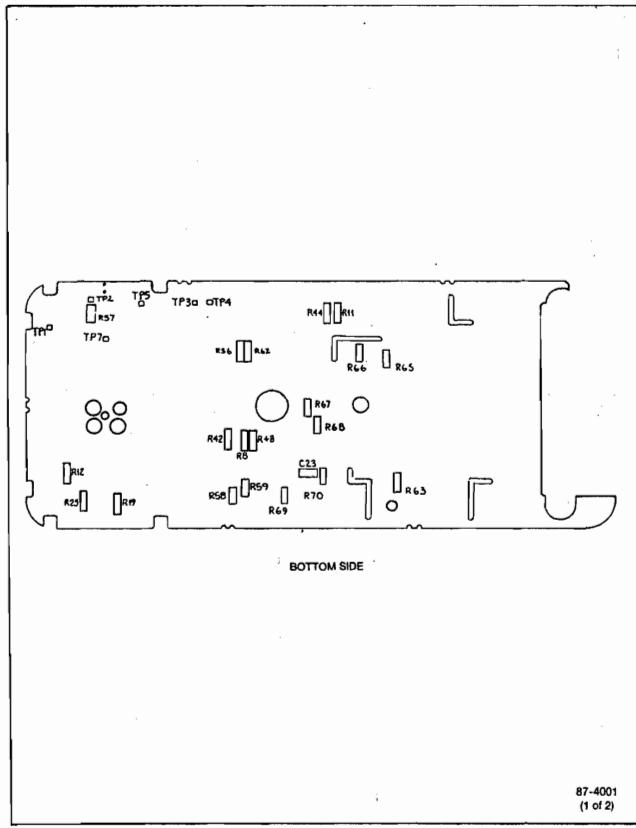


Figure 4-6. Fluke 87 A1 Main PCA

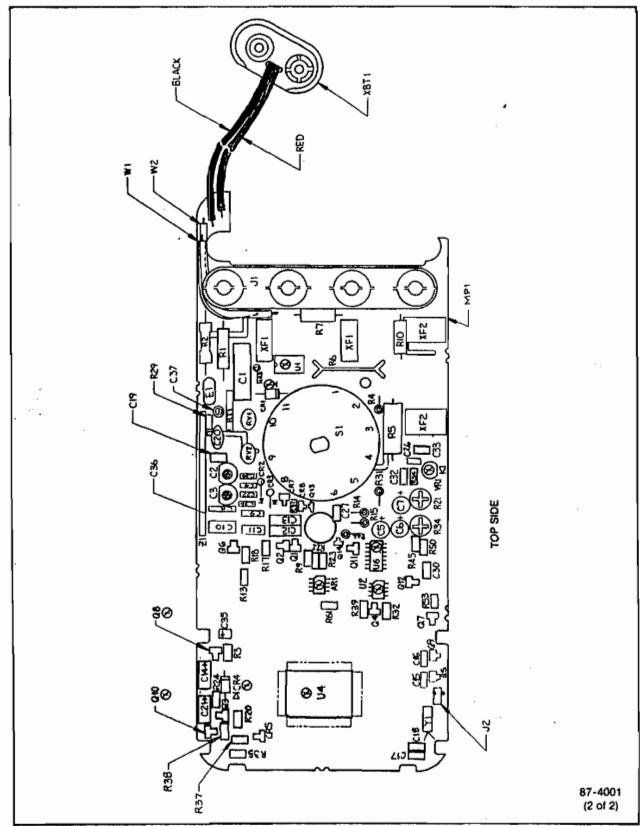


Figure 4-6. Fluke 87 A1 Main PCA (cont)

## Federal Supply Codes for Manufacturers

<b>01295</b> Texas Instruments Inc. Semiconductor Group Dallas, TX	<b>23237</b> I.R.C. Inc. Microcircuits Div Philadelphia, PA	<b>61429</b> Fox Electronics Fort Myers, FL
<b>04222</b> AVX Corp. AVX Ceramics Div. Myrtle Beach, SC	<b>25403</b> Philips Circuit Assemblies Formerly Amperex Electronic Corp. Slatersville, RI	<b>62786</b> Hitachi America Ltd. Semiconductor & IC Div. San Jose, CA
<b>04713</b> Motorola Inc. Semiconductor Products Sector Phoenix, AZ	<b>27014</b> National Semiconductor Corp. Santa Clara, CA	<b>68919</b> Inter-Technical Group Inc., The Wima Division Elmsford, NY
<b>05347</b> Utronix Inc. (Tel Labs) Grand Junction, CO	<b>32997</b> Bourns Inc. Trimpot Div. Riverside, CA	<b>71400</b> Bussman - Now Magnum Div. of Cooper Industries Inc. St. Louis, MO
<b>09214</b> General Electric Co. Semiconductor Products Dept. Auburn, NY	<b>51406</b> Murata Erie, No. America Inc. Symrna, GA	<b>83583</b> Associated Spring Barnes Group, Inc. Gardena, CA
<b>0K392</b> Shin-Etsu Silicones of America (S.P. America) Torrance, CA	<b>54583</b> TDK Electronics Corp. Port Washington, NY	<b>88936</b> John Fluke Mfg. Co., Inc. Everett, WA
<b>14936</b> General Instrument Corp. Power Semiconductor Div. Hicksville, NY	<b>59124</b> KOA Speer Electronics Inc. Bradford, PA	<b>91984</b> Maida Development Co. Hampton, VA
<b>17856</b> Siliconix Inc. Santa Clara, CA	<b>59717</b> Eveready Battery Co. Inc. Asheboro, NC	<b>91984</b> Maida Development Co. Hampton, VA

## Service Centers

USA	INTERNATIONAL
<b>California</b>	<b>Australia</b>
FLW	Philips Bus. and Ind., Pty. L.
Fluke Calibration Center	Av. Brasilia, Cest. Supp. Serv.
C/o FLW Service Corporation	P.O. Box 42
3505 Calder Ave., Bldg E	1300 Sofia, Bulgaria
Costa Mesa, CA 92626	Victoria 3170
TEL: 714-731-3656	TEL: 369-200785
FAX: 714-731-3532	FAX: 369-220910
	TEL: 693-2-230283 or 520000
	FAX: 563-2-561190
<b>Delaware</b>	<b>C.F.R.J.R.</b>
Fluke Service Center	Phil. Ed. J. Ind. Bld. F, Centro.
2104 Nutten Drive	Elie
Suite 112	NA, Service 2
Carrollton, TX 75006	10000 Rybka
TEL: 214-406-1000	16000 Rybka
FAX: 214-347-9848	TEL: 42-519-4810
	TEL: 42-351-0966
<b>Florida</b>	<b>Bulgaria</b>
Fluke Service Center	Fluke Vertriebsges., GMBH (G&G)
42711 Lawrence Place	Budweiserstrasse 7
Fremont, CA 94538	11000 Bens
TEL: 916-651-112	TEL: 20-2-417-4294
FAX: 916-651-092	FAX: 20-2-417-4296
<b>Illinois</b>	<b>Asiatic</b>
Fluke Service Center	Fluke Elektronik BRNO
1150 W. Euclid Avenue	Brno 613 00
Palatine, IL 6007	TEL: 42-57405-02
TEL: 708-705-0600	TEL: 42-57405-02
FAX: (847) 705-5600	FAX: 42-514-1010
<b>Indiana</b>	<b>Bahrain</b>
Fluke Service Center	Mohammed Fahroo & Sons
1150 W. Euclid Avenue	400 Bahrain Rd East, Ux 81
Palatine, IL 6007	TEL: 877-77 Temsung/Munich
TEL: 708-705-0600	1427 130
FAX: 911-888-27996	TEL: 49-89-991-1290
	FAX: 49-89-991-1270
<b>Michigan</b>	<b>Belgium</b>
Fluke Service Center	M.V. Fluke Belgium S.A.
8000 St. Peters - Leuven	Brussels, Belgium
TEL: (201) 988-6800 (986-0919)	TEL: 201-4-331-0777 (ext 218)
FAX: (201) 988-2063	FAX: 32-2-331-1466
<b>Massachusetts</b>	<b>Belgium</b>
Fluke Service Center	Fluke Electronics Canada Inc.
8000 St. Peters - Leuven	400 Britannia Rd East, Ux 81
TEL: (201) 988-6800 (986-0919)	TEL: 877-77 Temsung/Munich
FAX: (201) 988-2063	1427 130
	TEL: 49-89-991-1290
	FAX: 49-89-991-1270
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Fluke S.C., Room 2111
8000 St. Peters - Leuven	Sole Tower
TEL: (201) 988-6800 (986-0919)	Jiangxiangzhen, Dafu
FAX: (201) 988-2063	Building 10000, PRIC
	TEL: 358-0-8152-5600
	FAX: 358-0-8152-5600
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Fluke S.C., Room 2111
8000 St. Peters - Leuven	Sole Tower
TEL: (201) 988-6800 (986-0919)	Jiangxiangzhen, Dafu
FAX: (201) 988-2063	Building 10000, PRIC
	TEL: 358-0-8152-5600
	FAX: 358-0-8152-5600
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853
<b>Michigan</b>	<b>China</b>
Fluke Service Center	Guanda Vek 181 Of. 803
8000 St. Peters - Leuven	Castilla 18500, Santiago 9
TEL: (201) 988-6800 (986-0919)	TEL: 49-40-879-6434
FAX: (201) 988-2063	FAX: 49-40-879-7853

## Section 5 Schematic Diagrams

## TABLE OF CONTENTS

FIGURE	TITLE	PAGE
5-1.	Fluke 83 A1 Main PCA	5-3
5-2.	Fluke 85 A1 Main PCA	5-6
5-3.	Fluke 87 A1 Main PCA	5-9
5-4.	AC Current Signal Flow	5-12
5-5.	AC Volts Signal Flow (Models 83, 85)	5-14
5-6.	AC Volts Signal Flow (Model 87)	5-16
5-7.	Capacitance Signal Flow	5-18
5-8.	DC Current Signal Flow	5-20
5-9.	DC Millivolt Direct and DC Volts Signal Flow	5-22
5-10.	Diode Test Signal Flow	5-24
5-11.	Ohms Signal Flow	5-26
5-12.	Peak/Hold Signal Flow (Model 87)	5-28
5-13.	Function Switch Range Signal Flow	5-30

Table 5-1. Signal Abbreviations

ACBM	AC Buffer Minus (inverting input)	K1	Buffer output times 1
ACBO	AC Buffer Output	K2	Buffer output times 10
AFI	Active Filter Input	PDS	Power Down (off) Signal
AFO	Active Filter Output	P00	Port 00 (keypad)
AGND	Analog Ground	P01	Port 01 (keypad)
AP0	Analog Port 0 (guard)	P02	Port 02 (keypad)
AP1	Analog Port 1 (ohms, millivolts sense)	P03	Port 03 (PTF reference and position change sense)
AP2	Analog Port 2 (ohms reference sense)	P10	Port 10 (keypad)
AP3	Analog Port 3 (amps sense)	P11	Port 11 (keypad)
AP4	Analog Port 4 (milli/micro amps jack sense)	P12	Port 12 (keypad)
AP5	Analog Port 5 (amps jack sense)	P13	Port 13 (PW2, RMS power down drive)
AP6	Analog Port 6 (PTF position sense)	PS0	Power Supply 0 (feed back for VDD regulator)
AP7	Analog Port 7 (peak hold min sense)	PS1	Power Supply 1 (feed back for common regulator)
AP8	Analog Port 8 (peak hold max sense)	PS2	Power Supply 2 (output for common regulator)
APV0	Analog Port Voltage 0 (divider input)	PW2	Power 2 (power down drive for RMS converter)
APV1	Analog Port Voltage 1 (divide by 10)	REFH	Reference High (1.23V)
APV2	Analog Port Voltage 2 (divide by 100)	REFI	Reference In (1.00V)
APV3	Analog Port Voltage 3 (divide by 1000)	RESET	Reset for $\mu$ P
APV4	Analog Port Voltage 4 (divide by 10000)	S0	LCD Segment drive 0
APCC	Analog Port Compensation Capacitor	•	
AVAM	Absolute Value Amplifier Minus (inverting input)	S31	LCD Segment drive 31
AVAM0	Absolute Value Amplifier Output Minus	TEST	Factory Test
AVAO0	Absolute Value Amplifier Output Positive	VBT+	Plus battery voltage
AZ	Auto Zero	VBT-	Minus battery voltage
CK1	Clock 1 (RC clock output)	VDD	Plus system supply
CK2	Clock 2 (RC clock input)	VDGND	Digital Ground
COM	Common	VOA	2/3 voltage for LCD drive
FAI	Filter Active Input	VOB	1/3 voltage for LCD drive
FAO	Filter Active Output	VSS	Minus system supply
H1	LCD backplane drive 1		
H2	LCD backplane drive 2		
H3	LCD backplane drive 3		
H4	LCD backplane drive 4		
INT	Integrator output		
K0	Buffer output times .874		

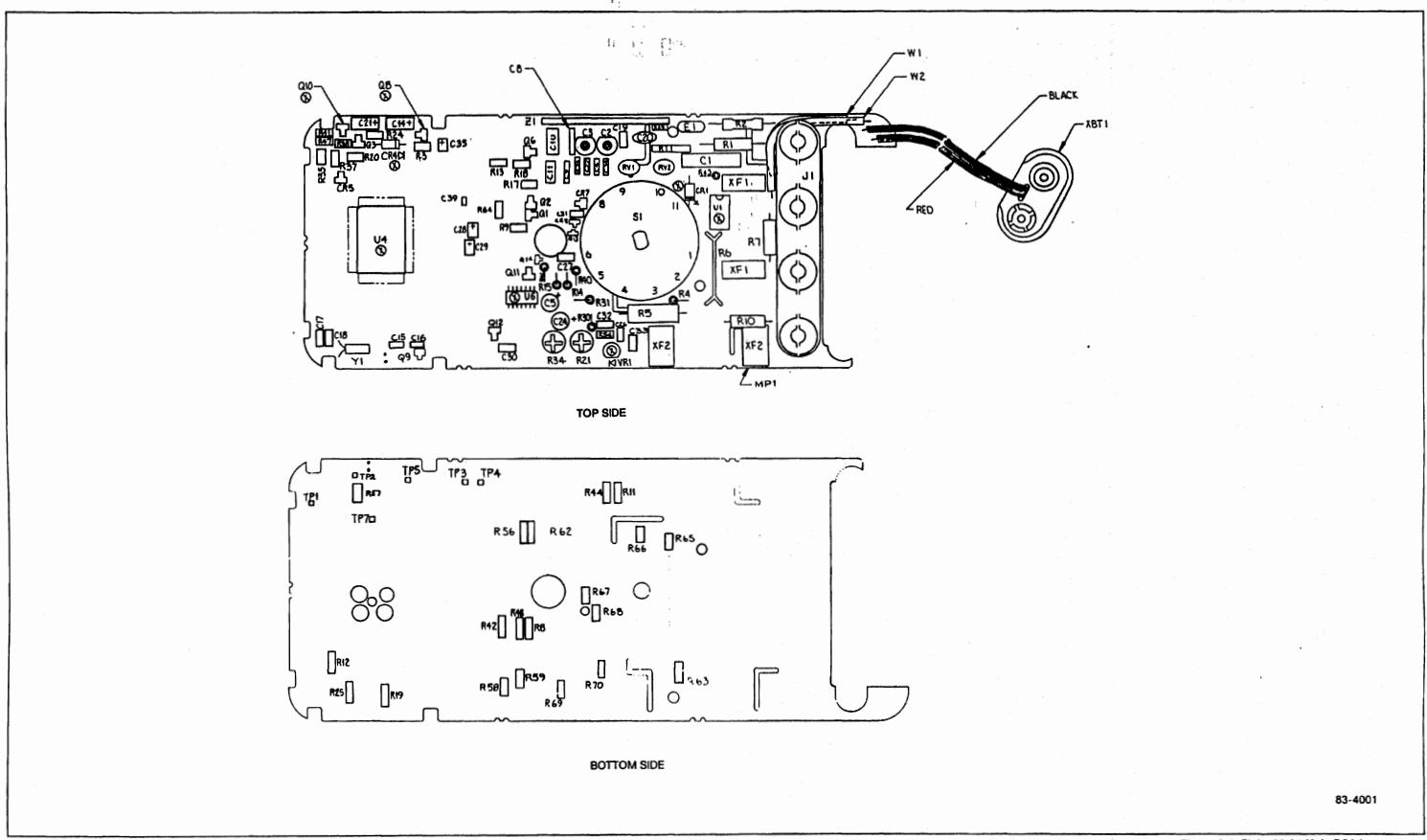
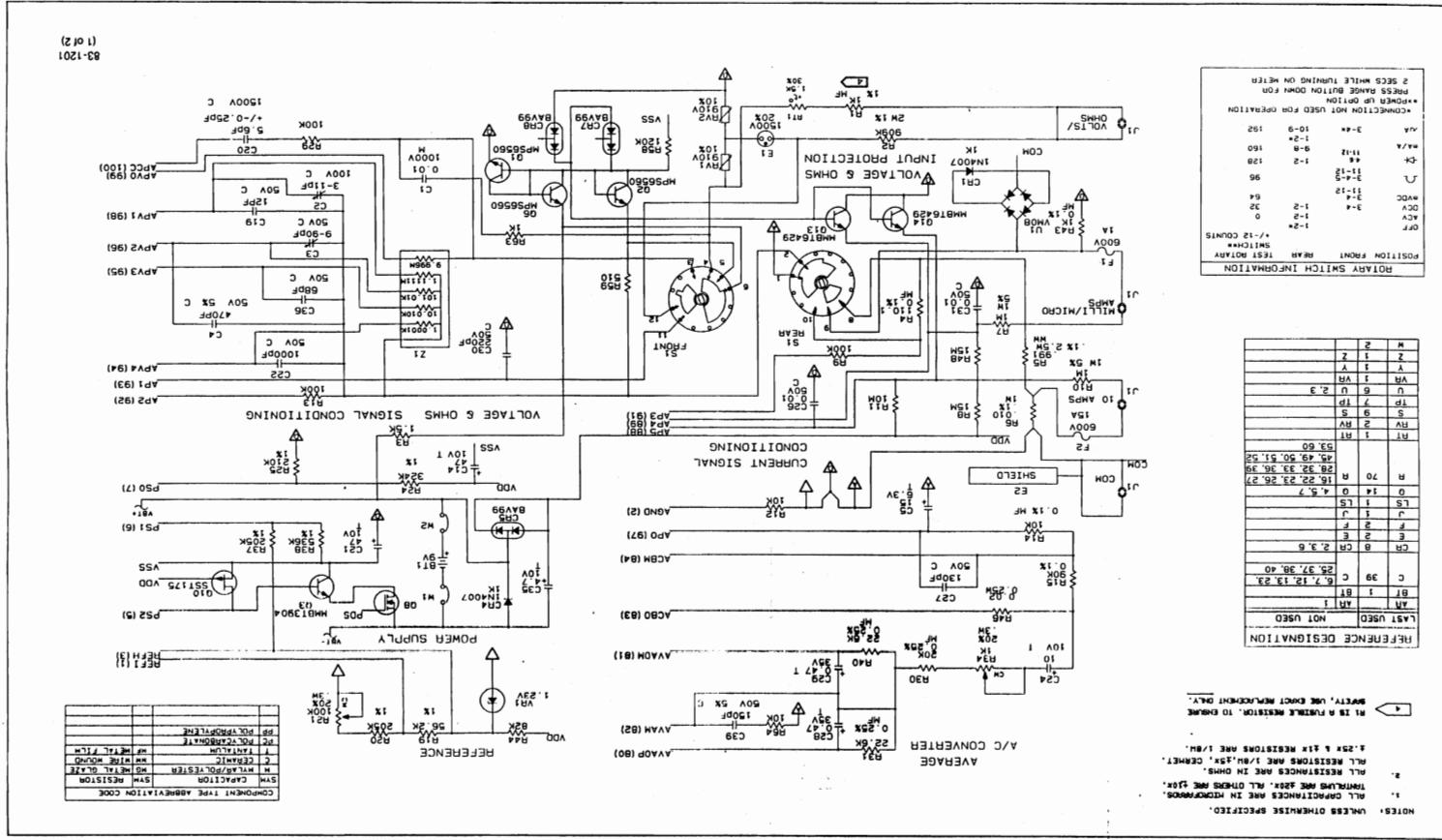
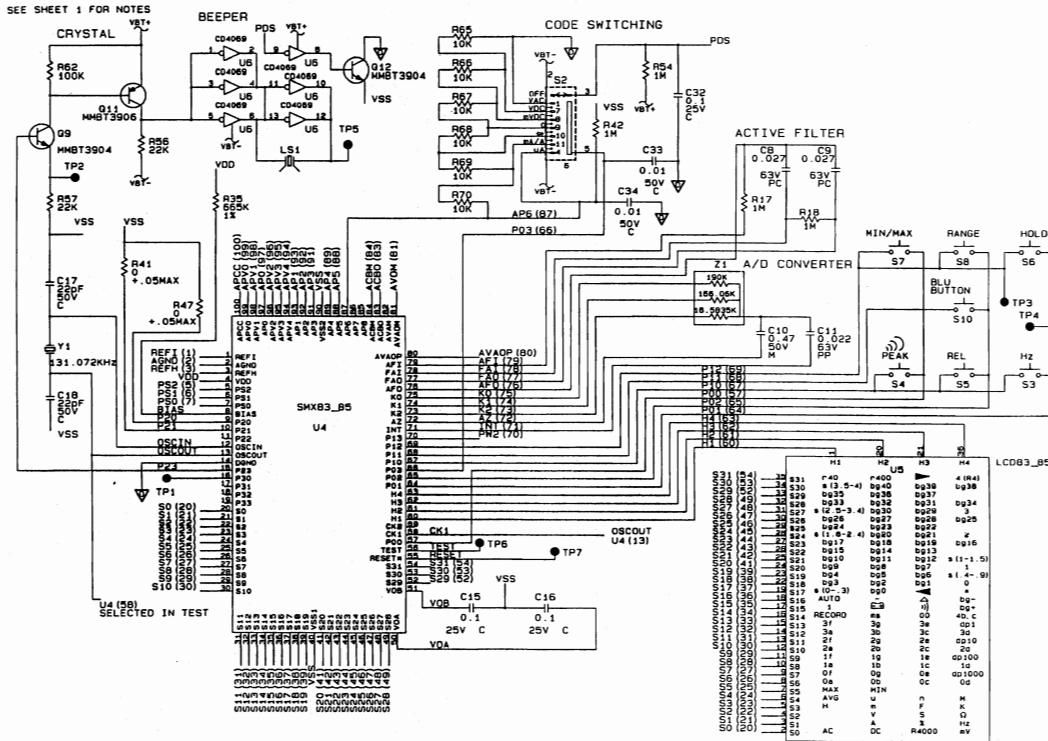


Figure 5-1. Fluke 83 A1 Main PCA

Figure 5-1. Fluke 83 A1 Main PCA (cont)





**Figure 5-1. Fluke 83 A1 Main PCA (cont)**

80 Series Service

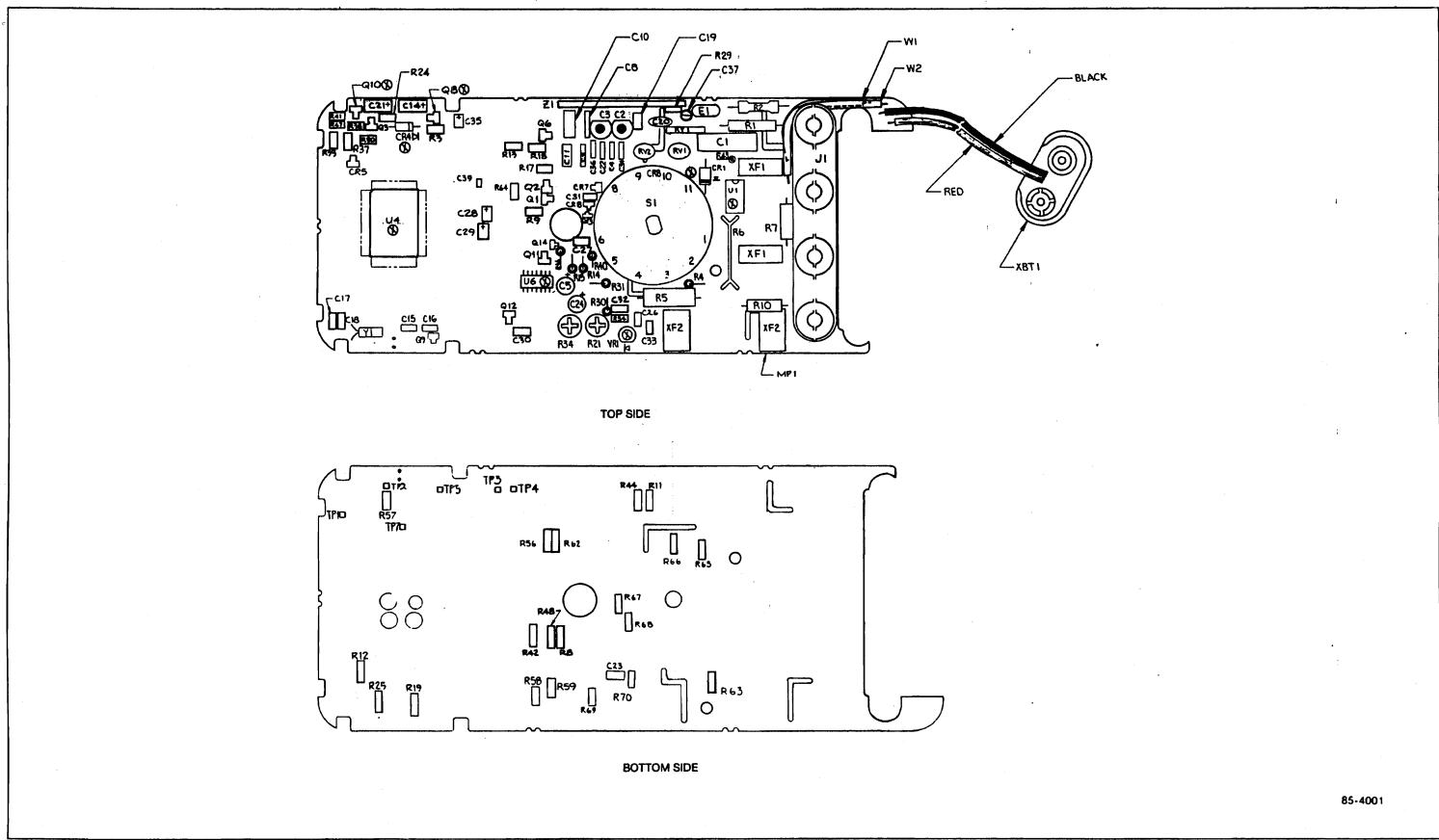


Figure 5-2. Fluke 85 A1 Main PCA

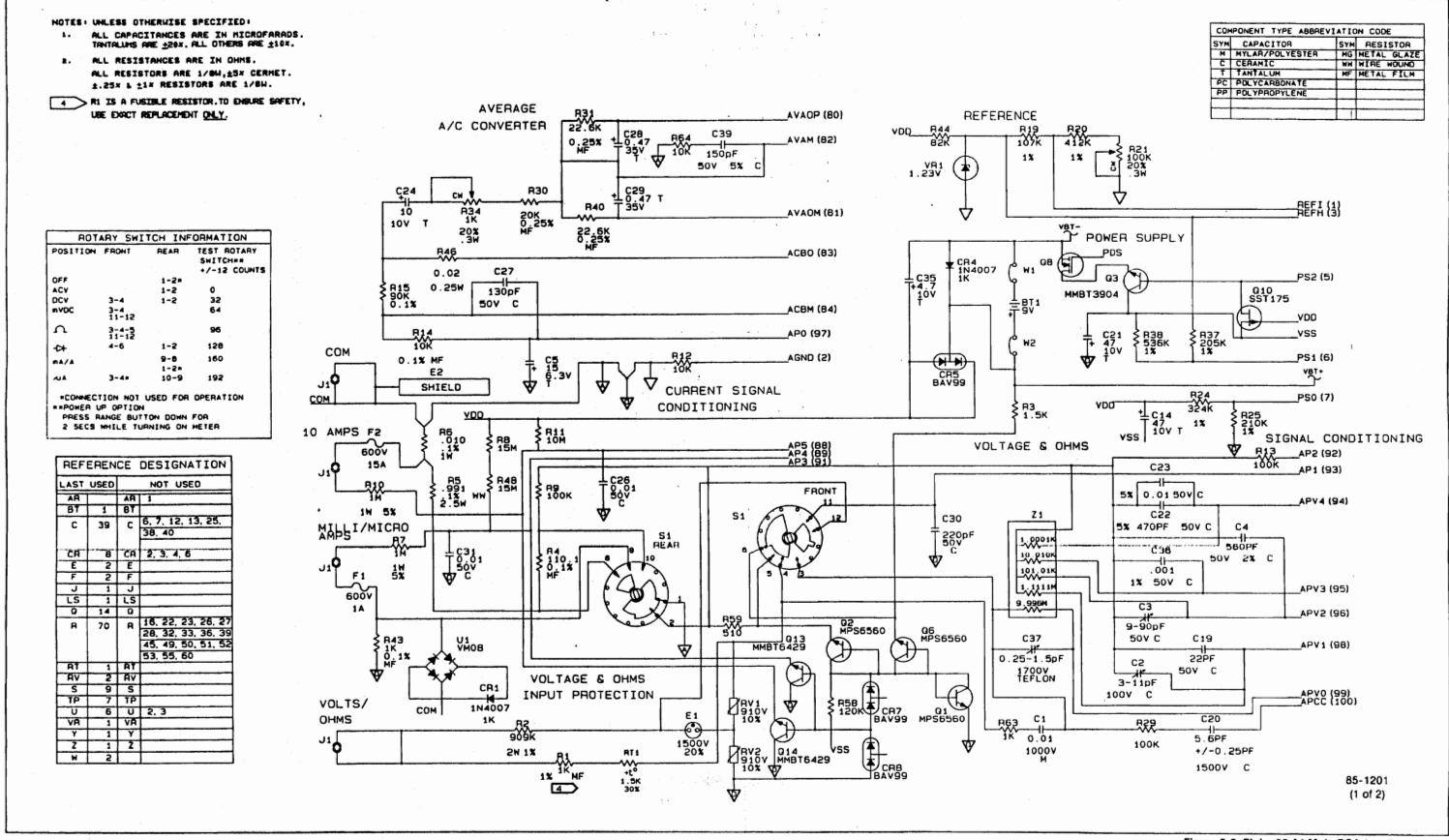
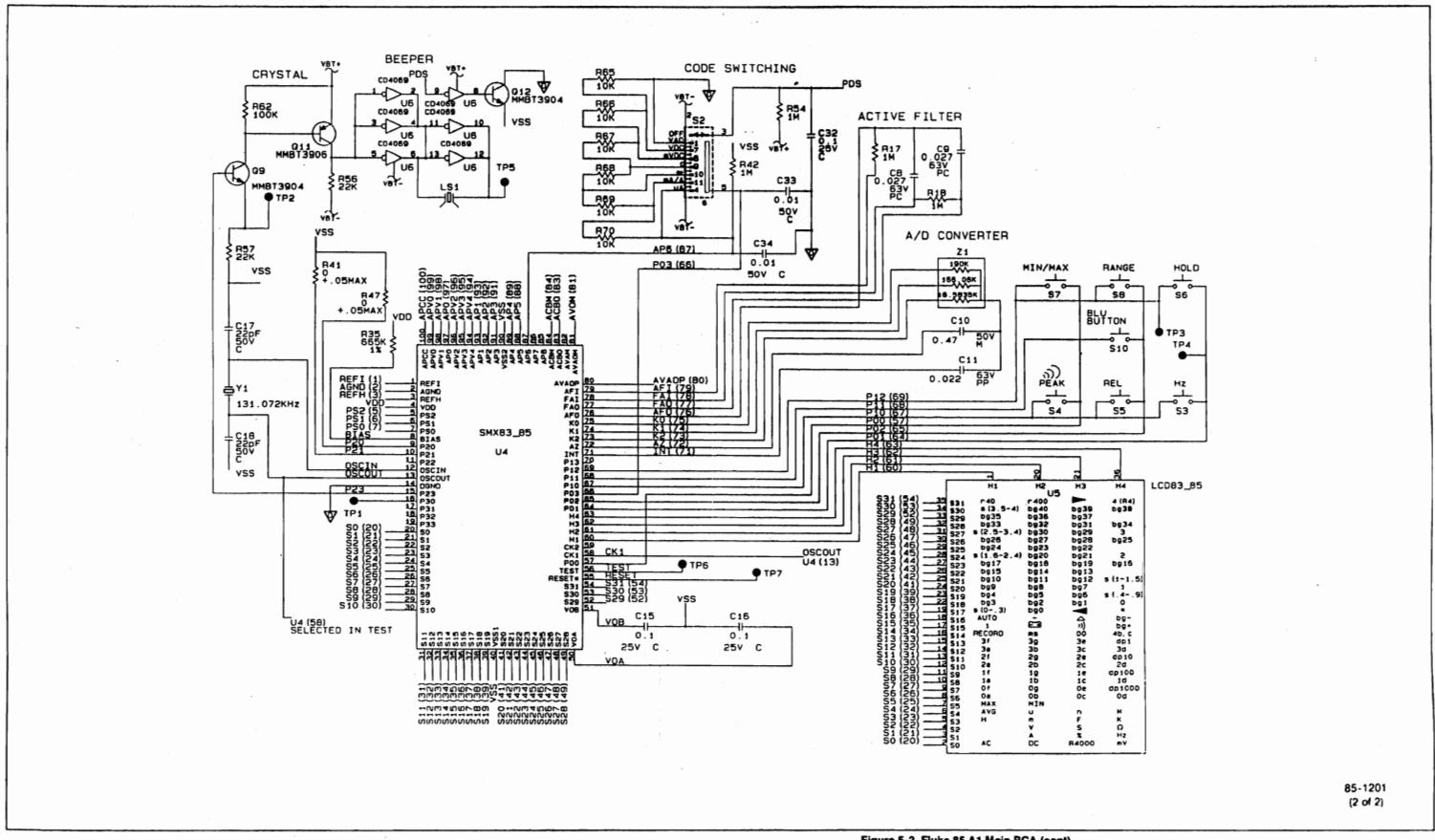
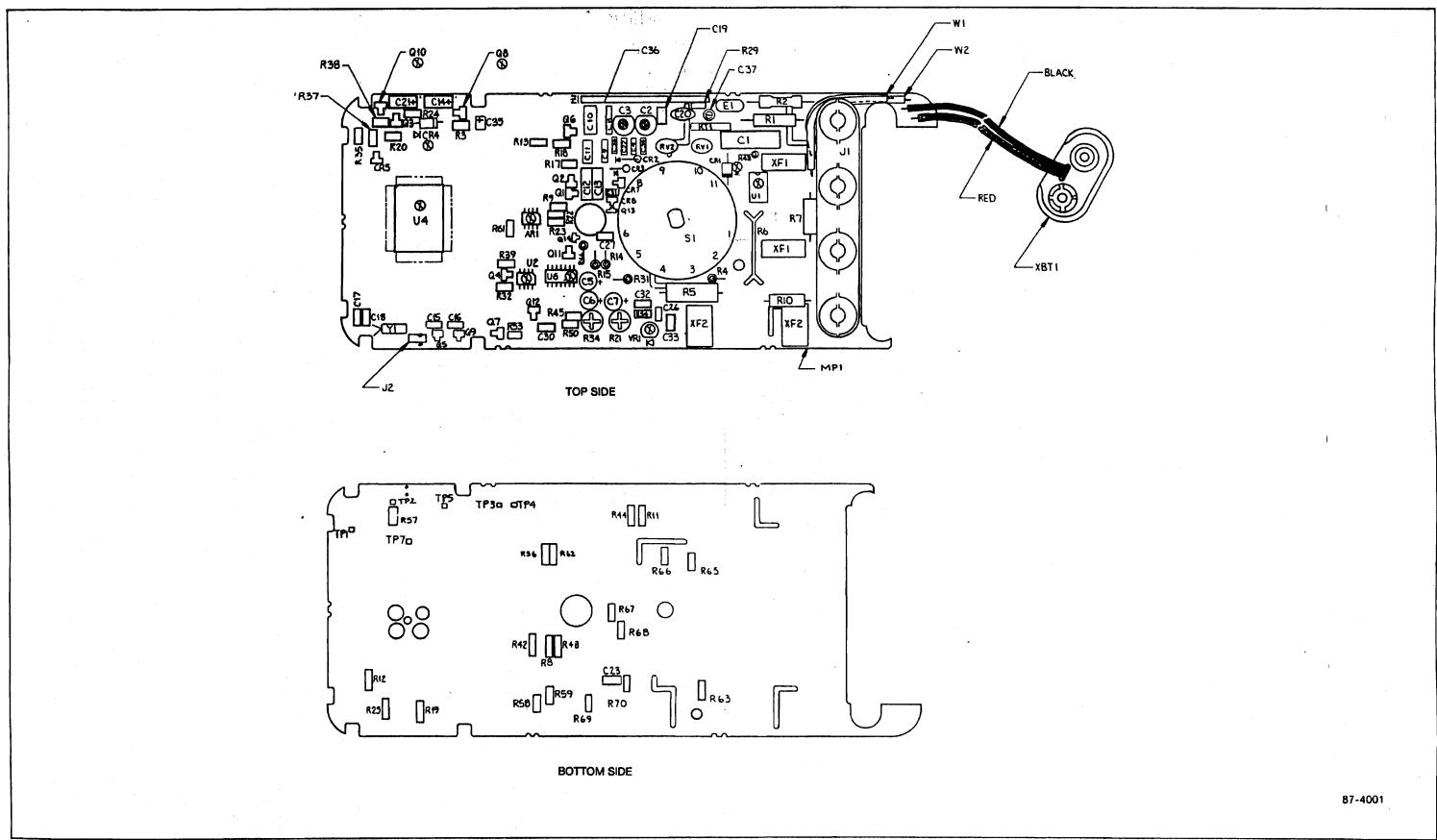


Figure 5-2. Fluke 85 A1 Main PCA (cont)





**Figure 5-3. Fluke 87 A1 Main PCA**

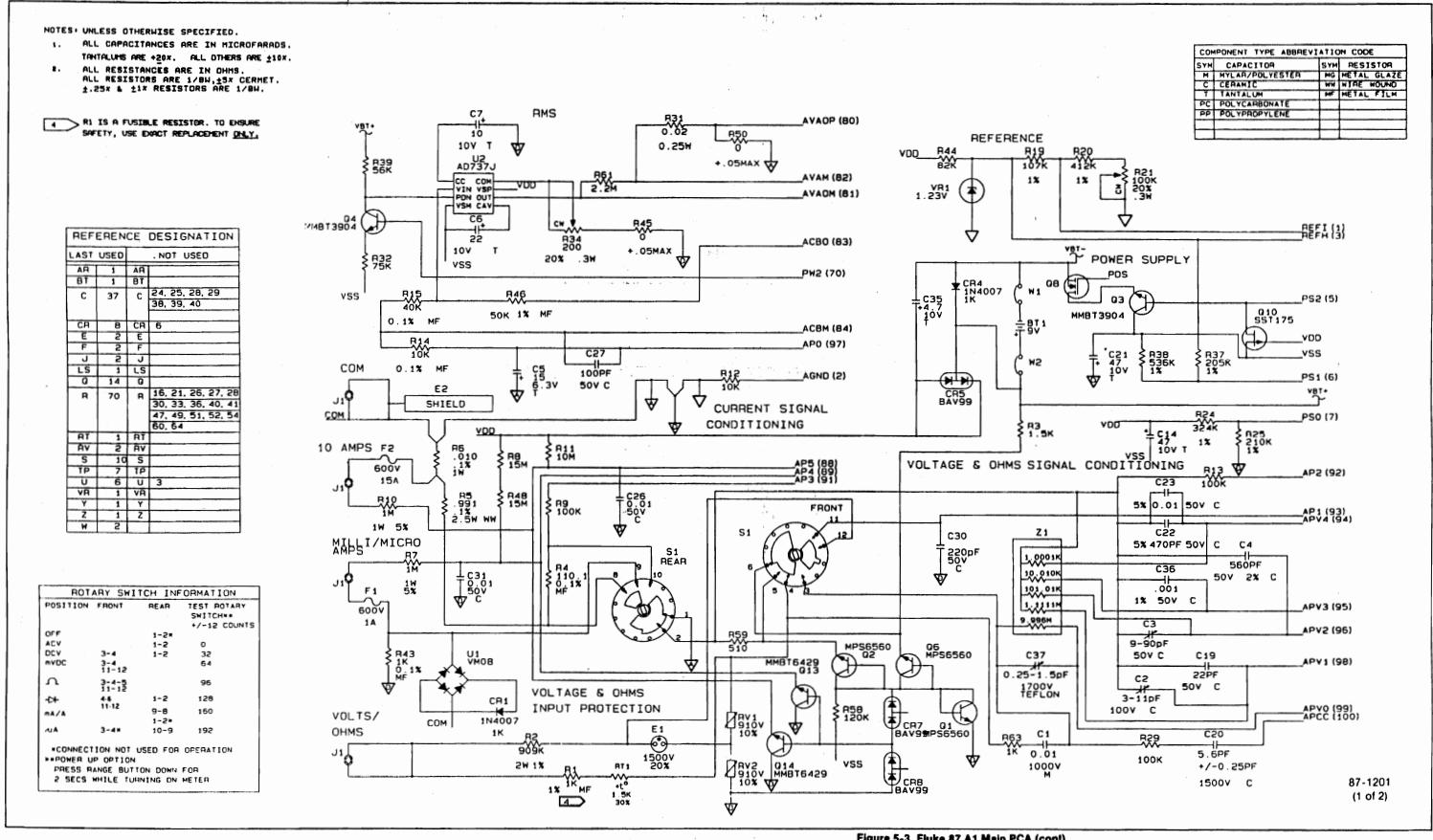


Figure 5-3. Fluke 87 A1 Main PCA (cont.)

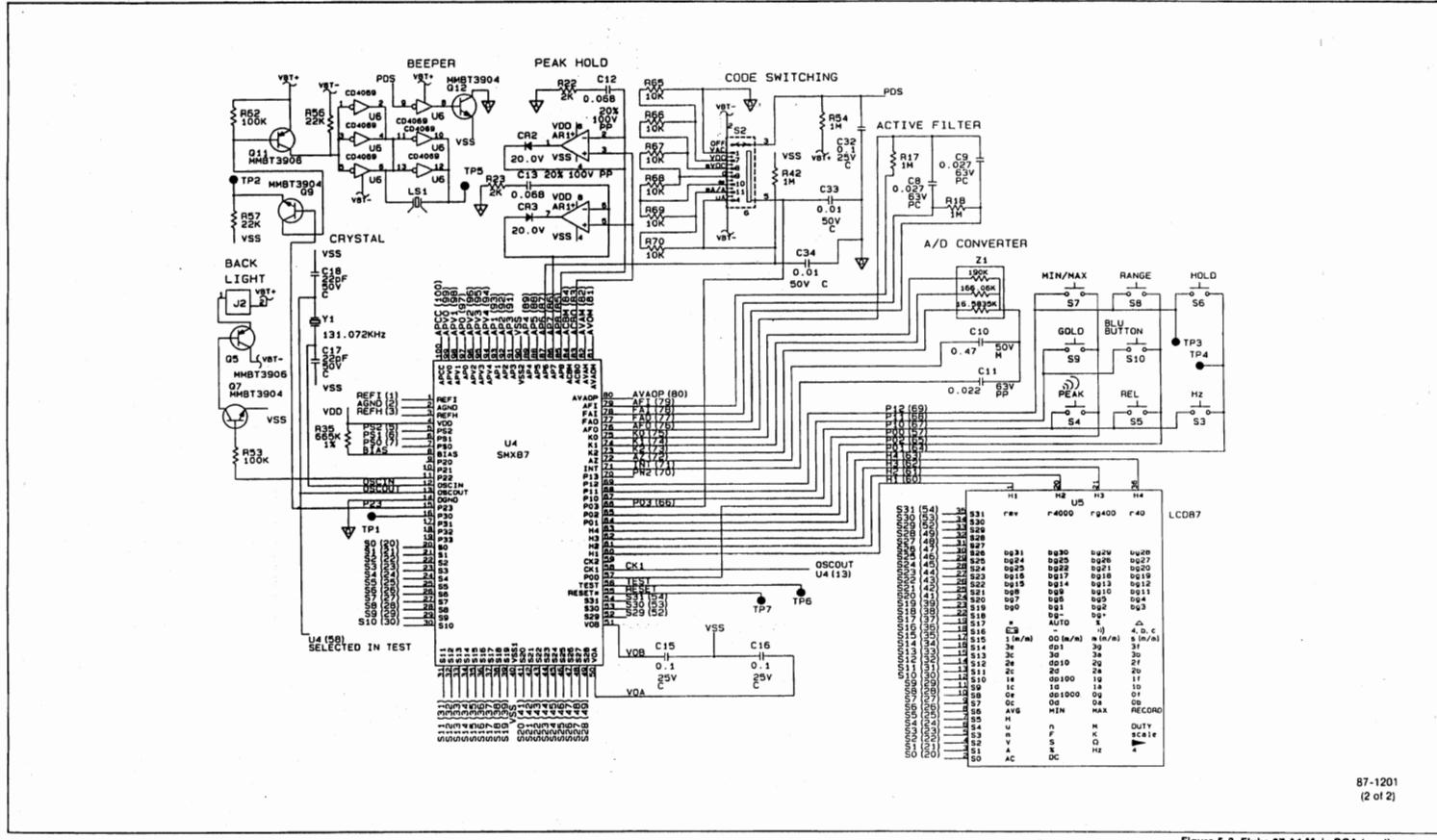


Figure 5-3. Fluke 87 A1 Main PCA (cont)

## 80 Series Service

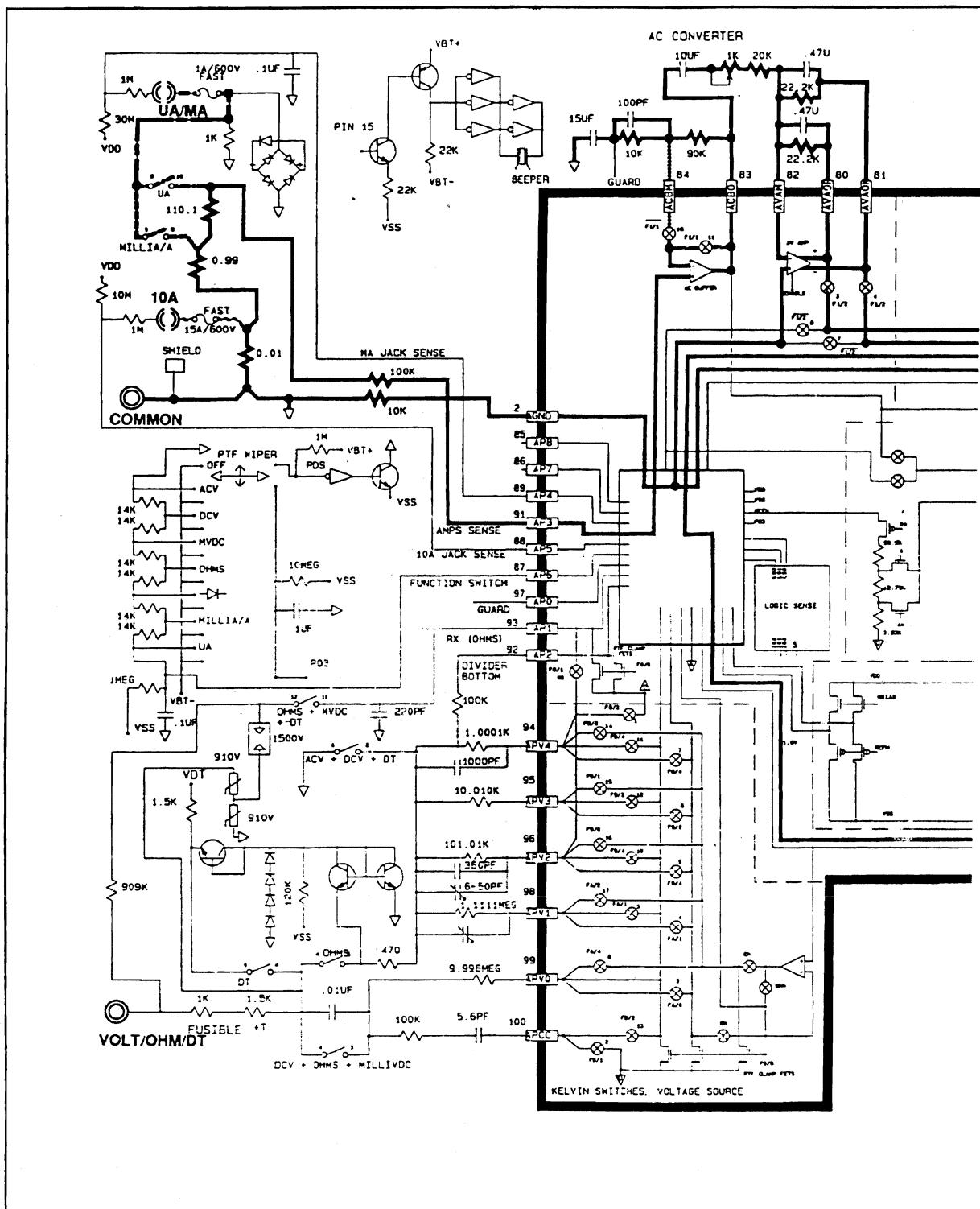
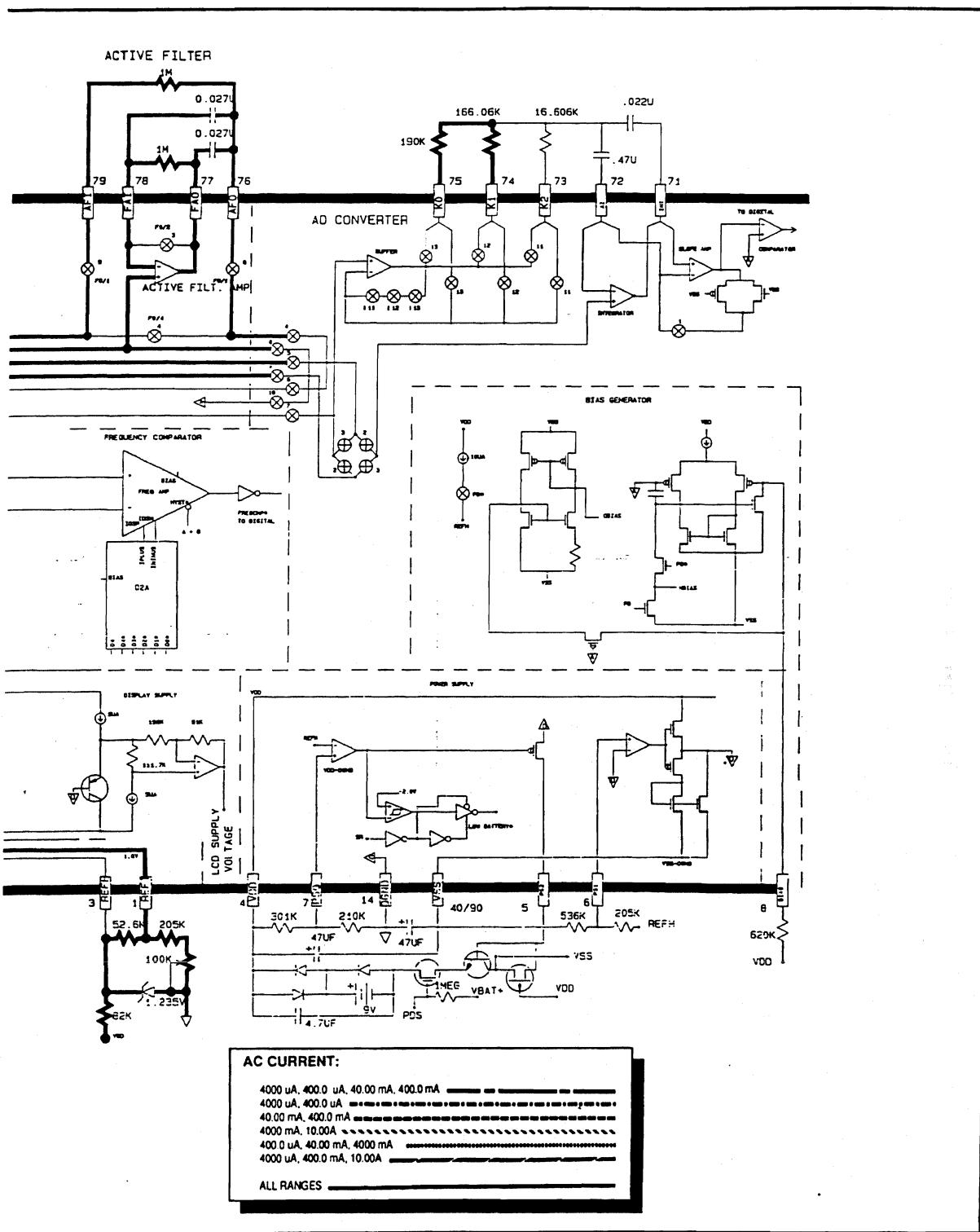
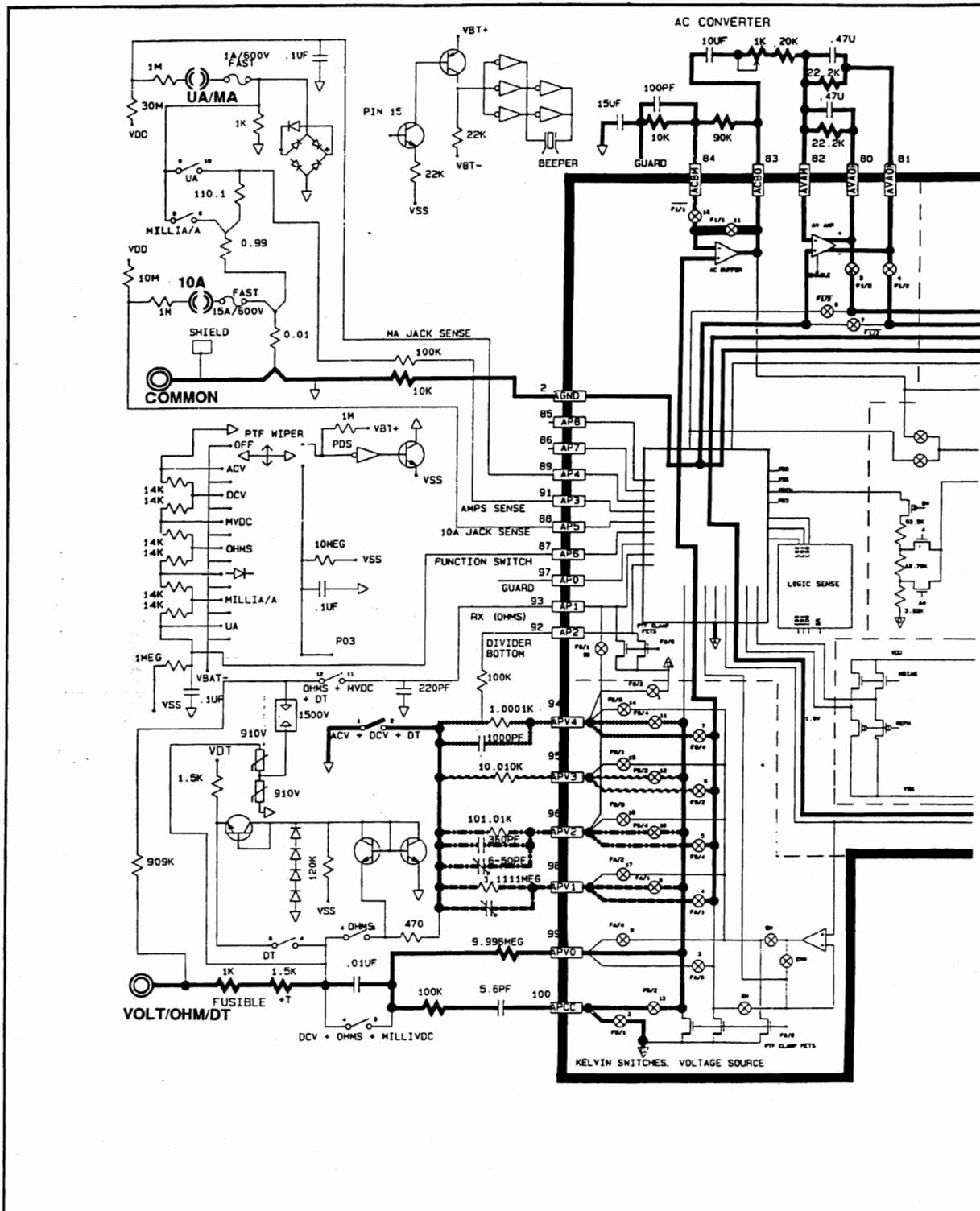
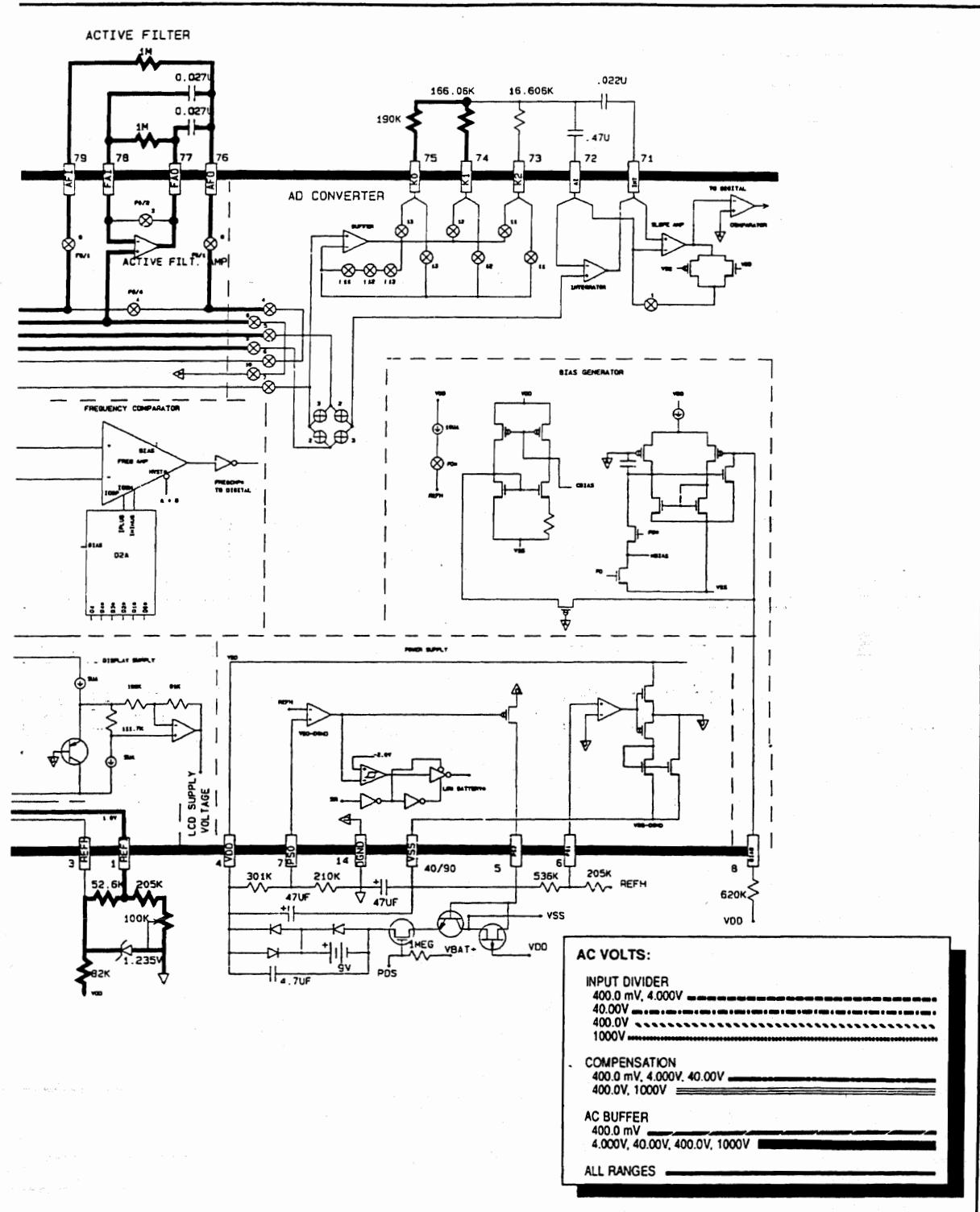


Figure 5-4. AC Current Signal Flow







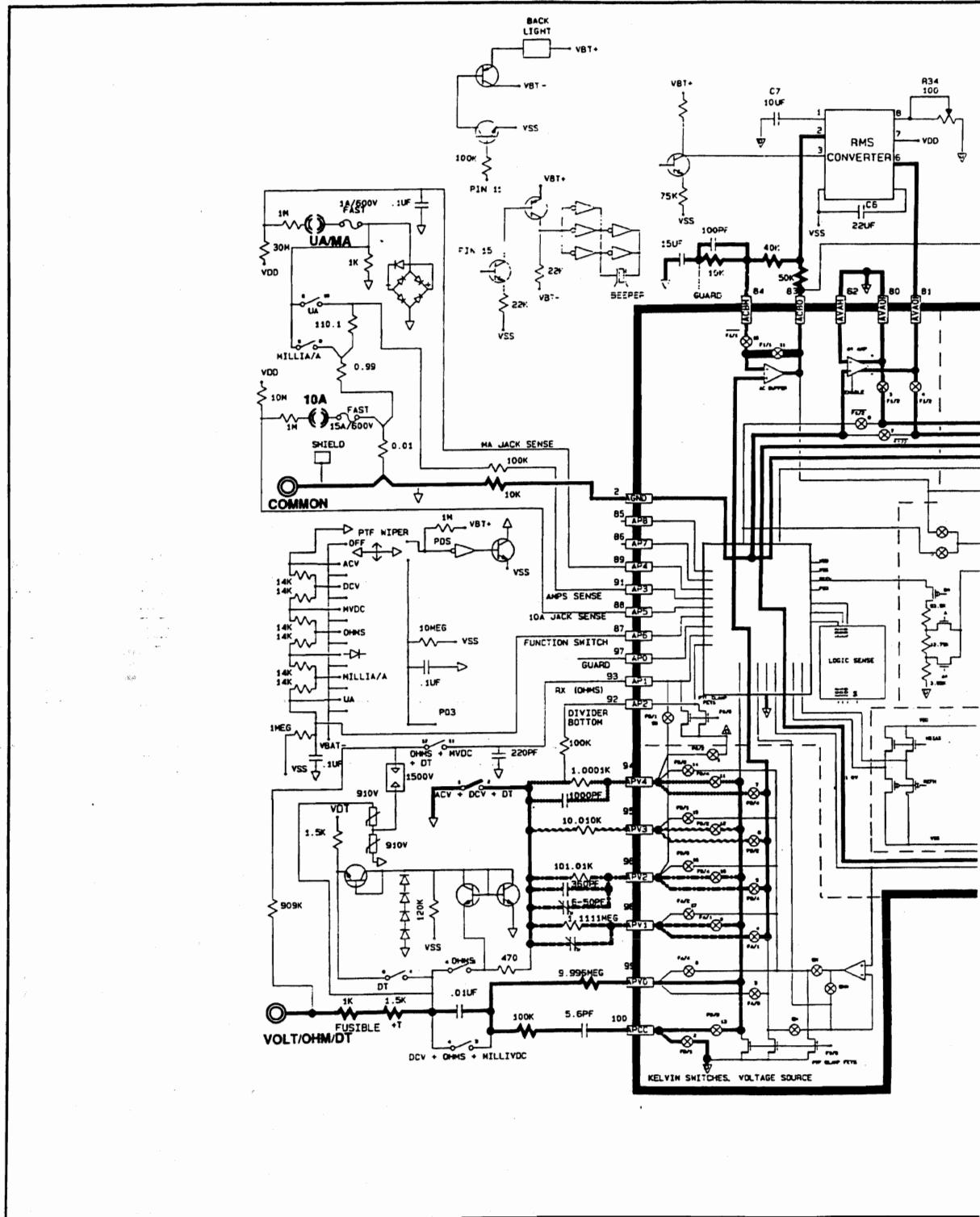
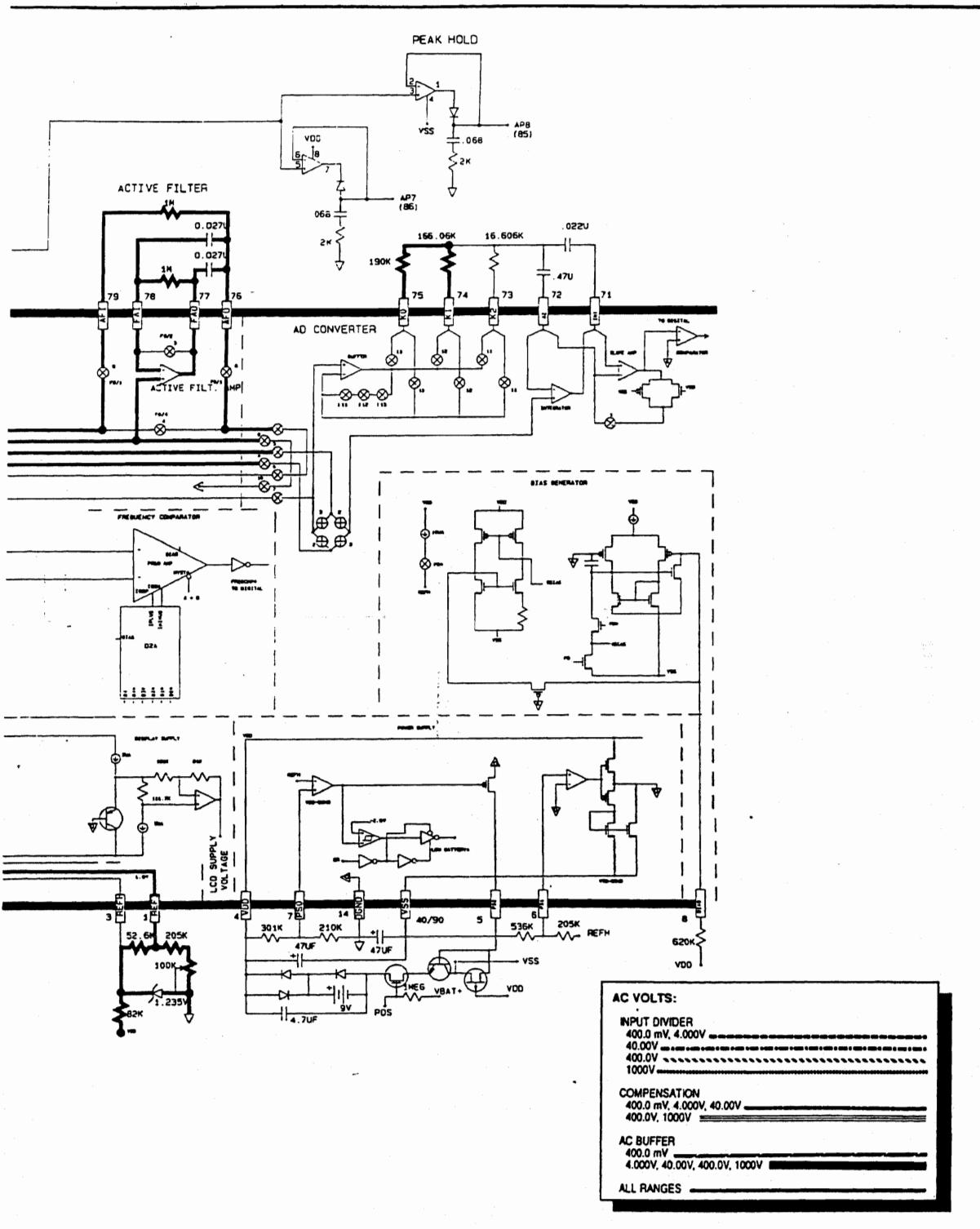
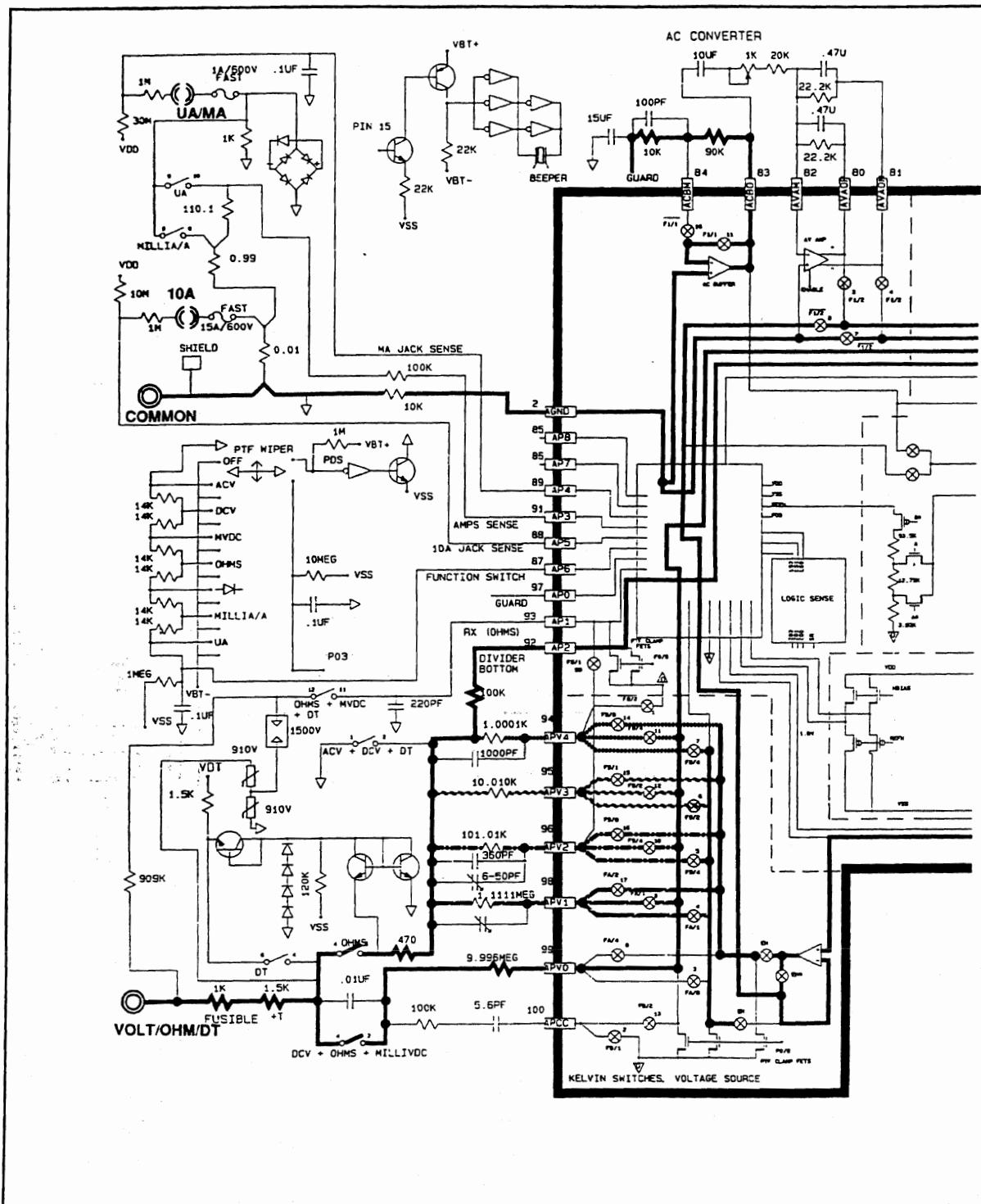
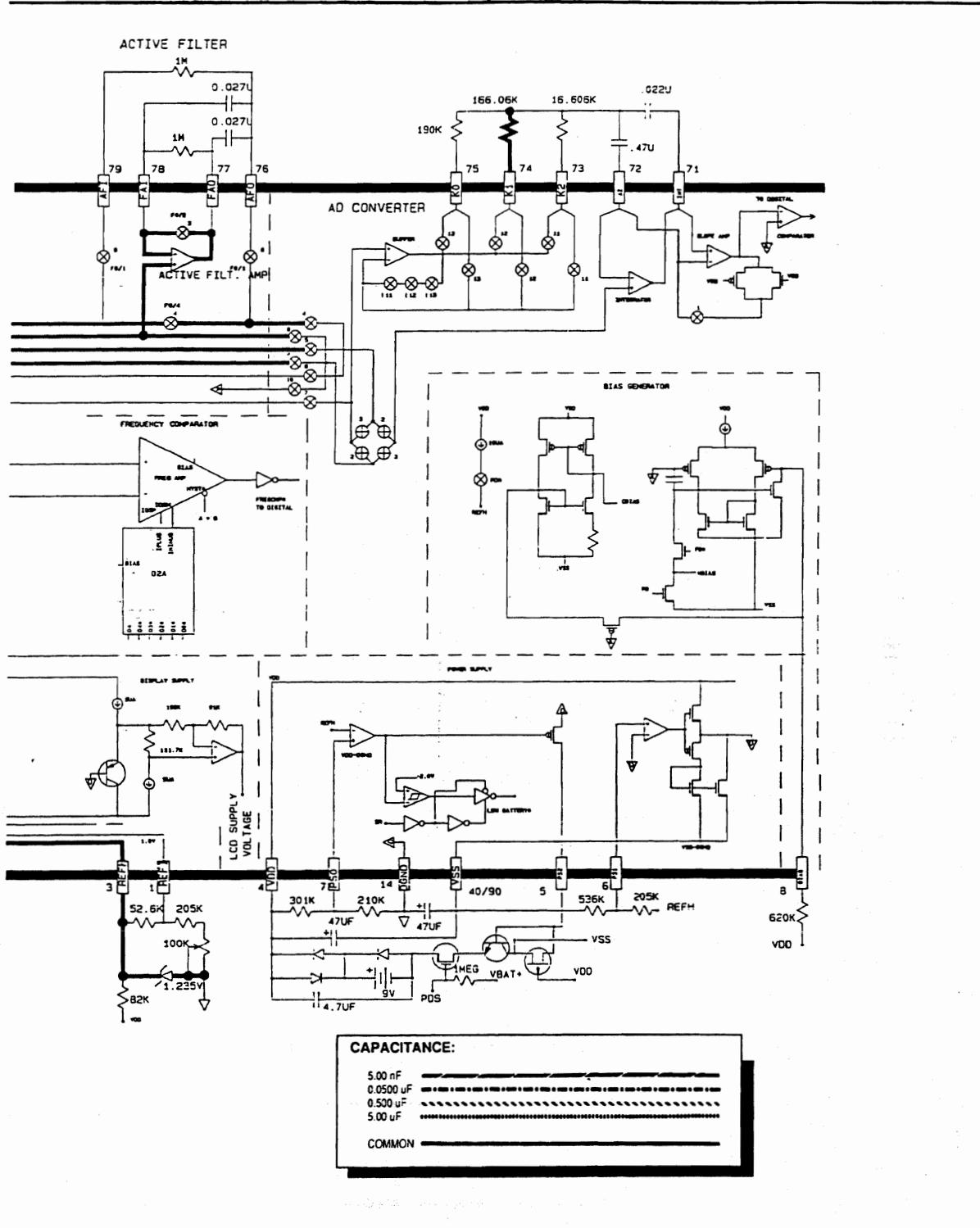


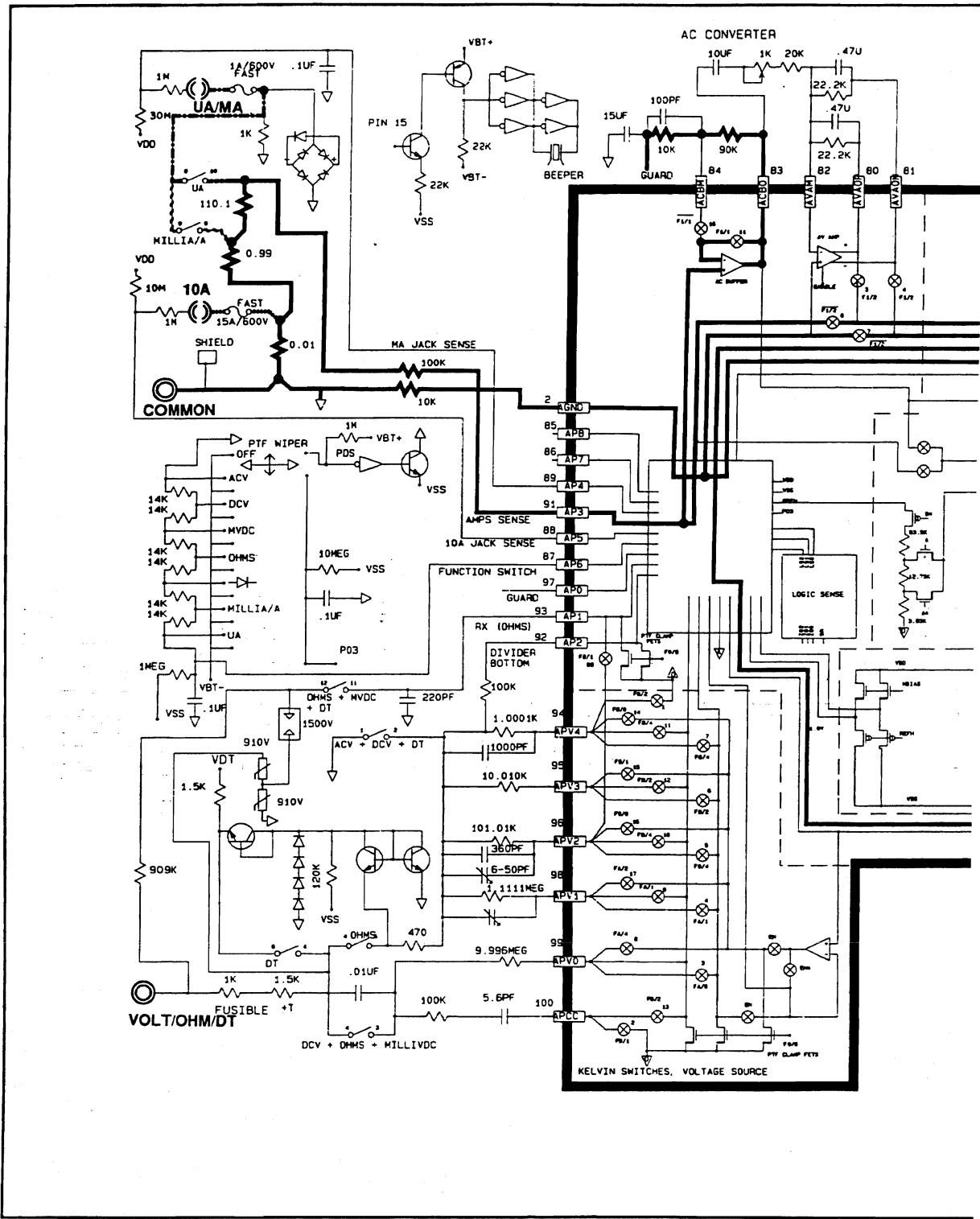
Figure 5-6. AC Volts Signal Flow (Model 87)

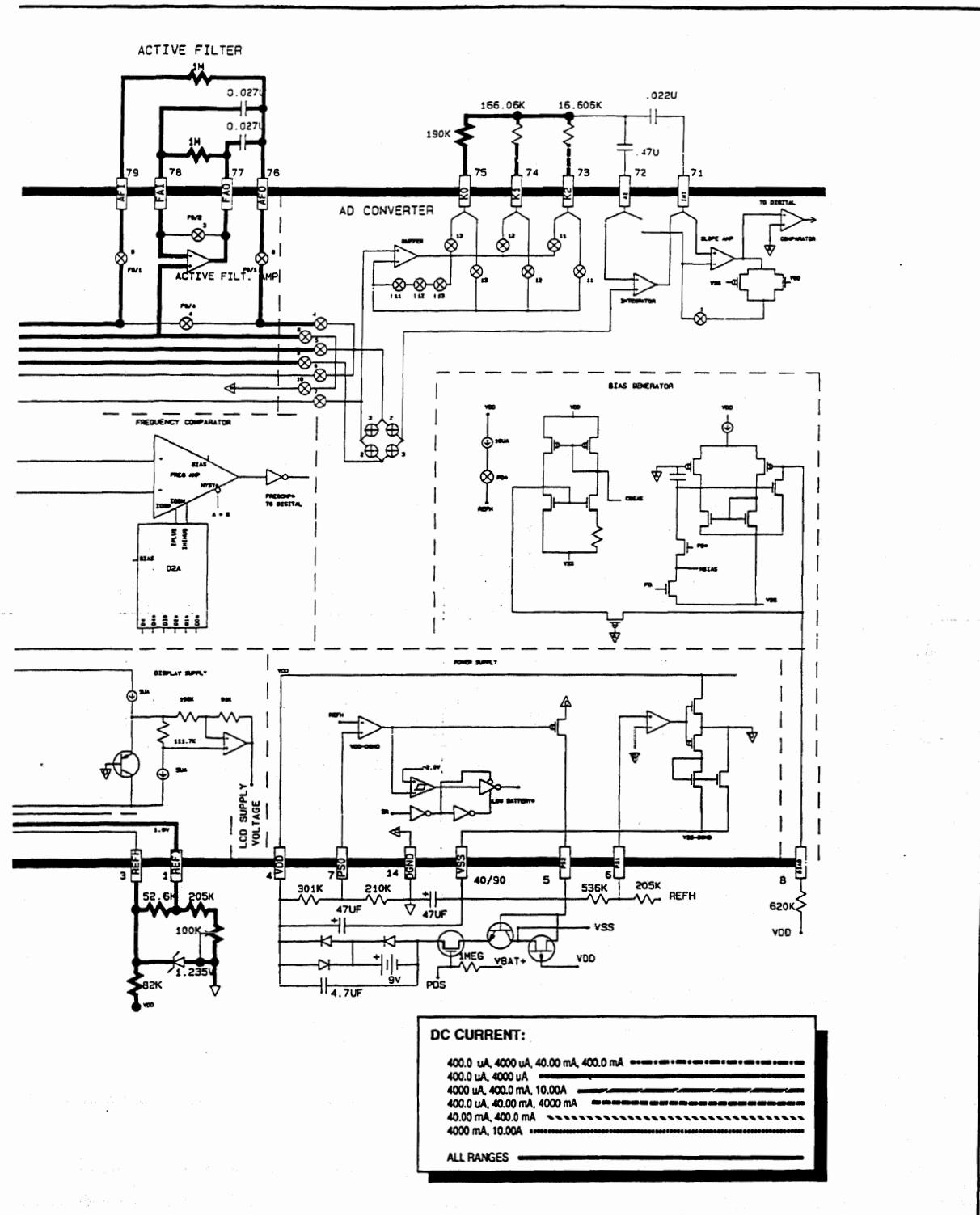


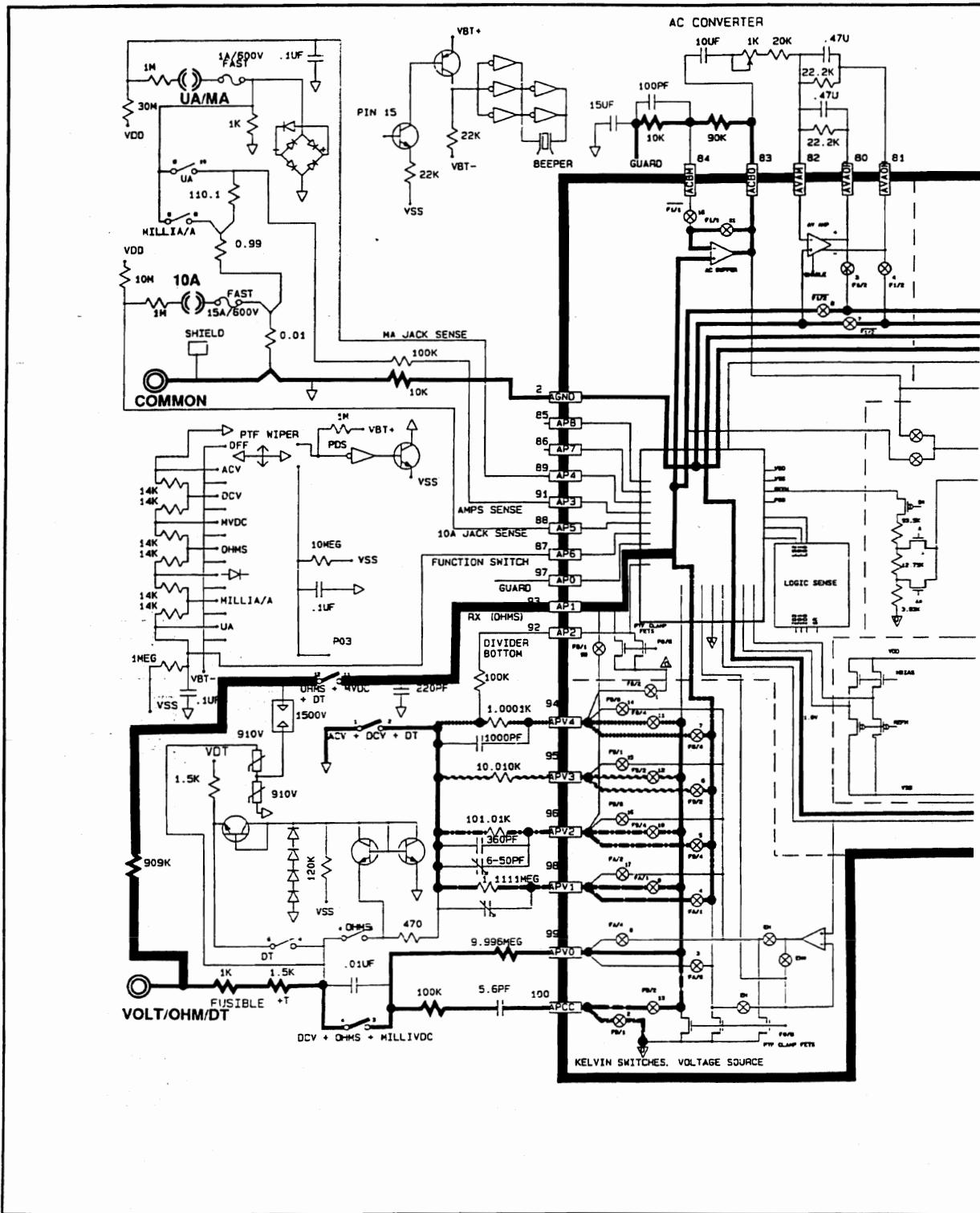


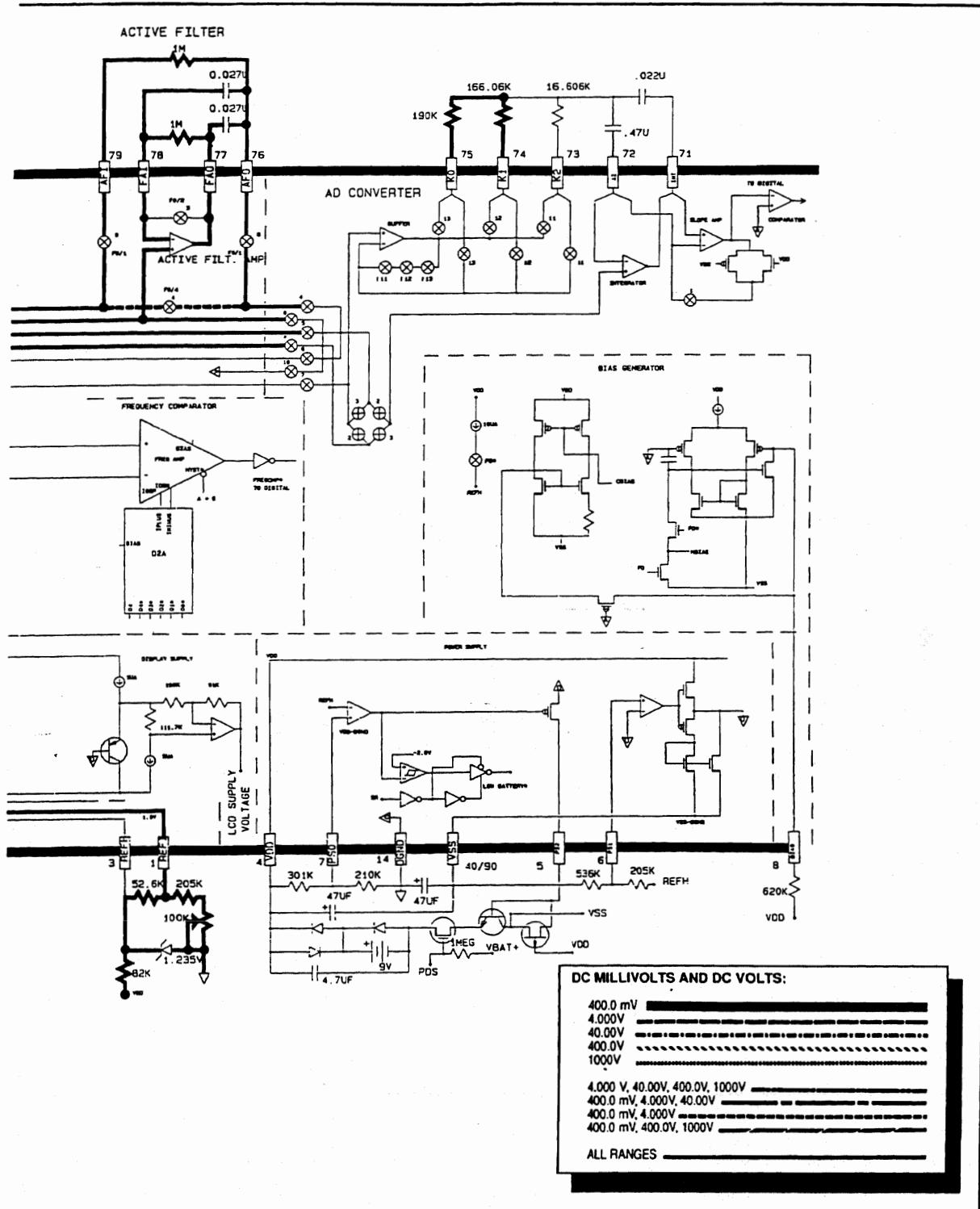
**Figure 5-7. Capacitance Signal Flow**

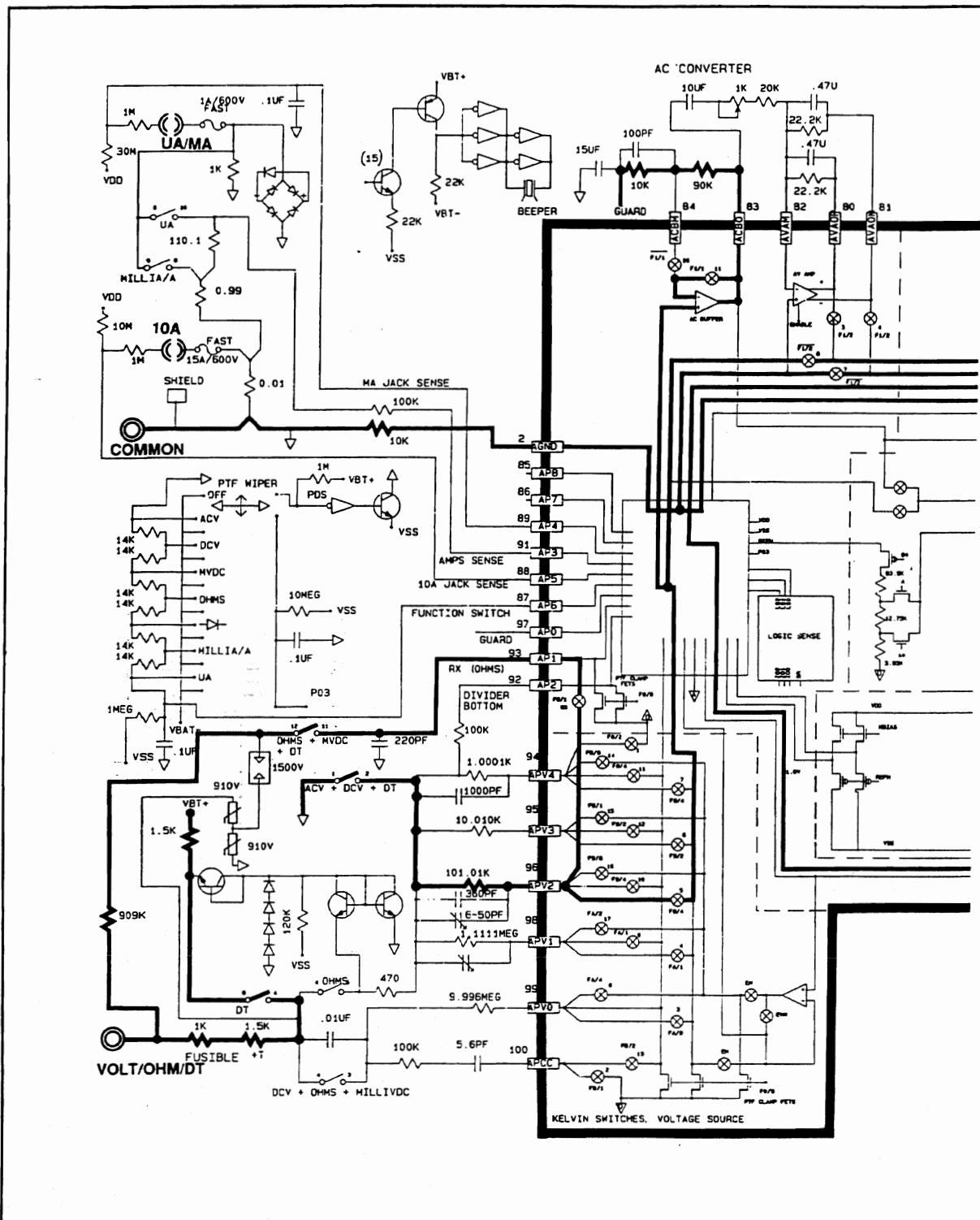




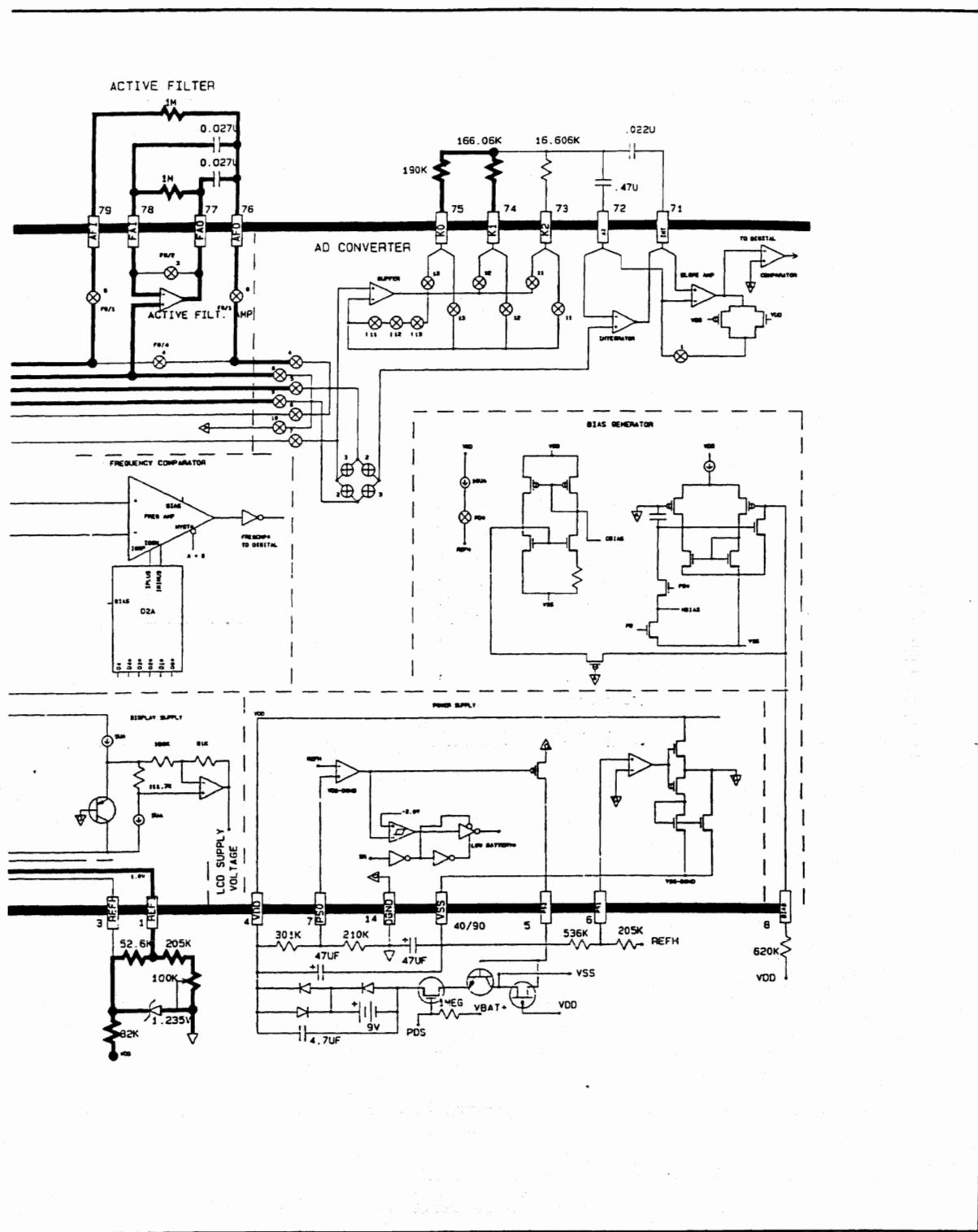








**Figure 5-10. Diode Test Signal Flow**



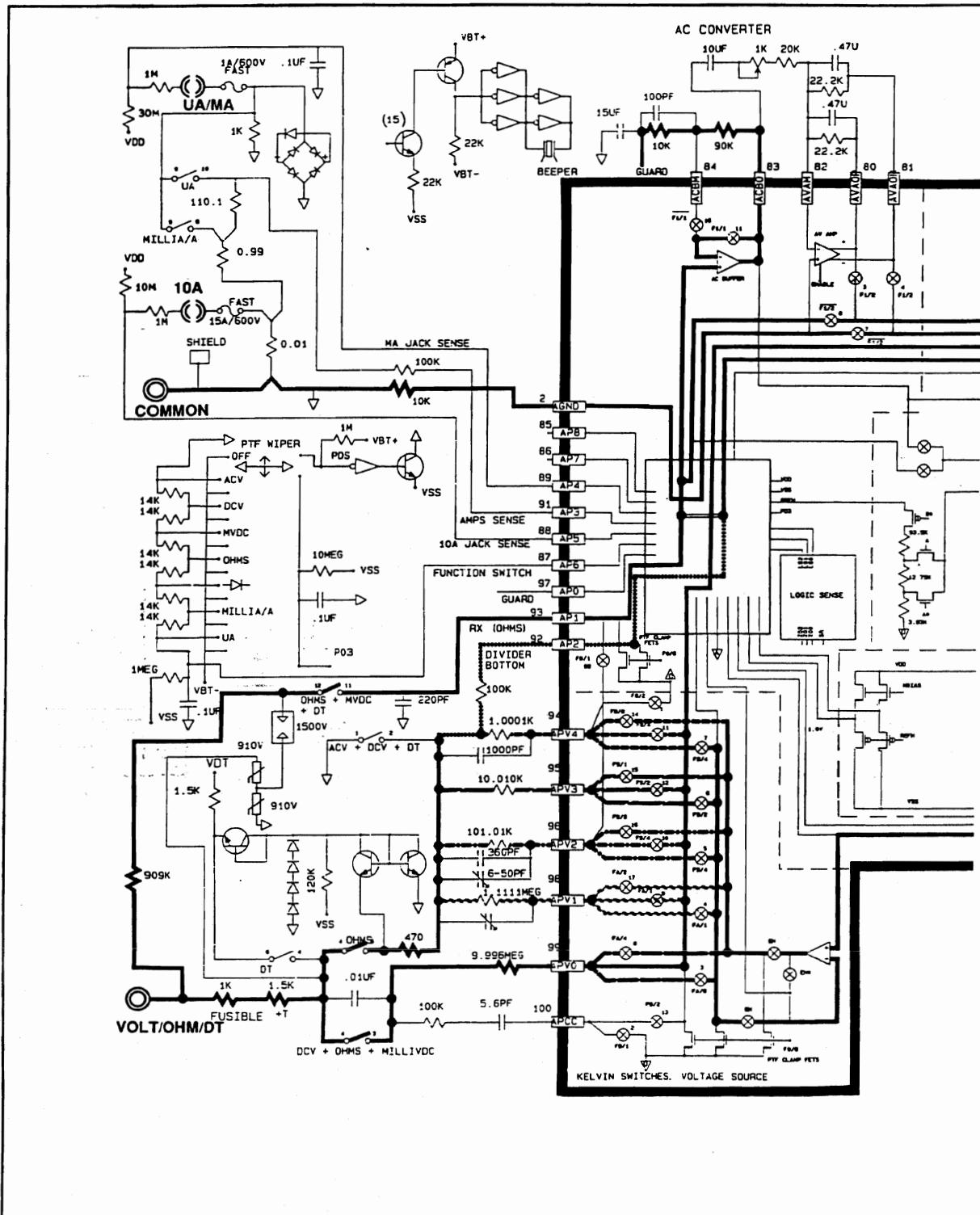
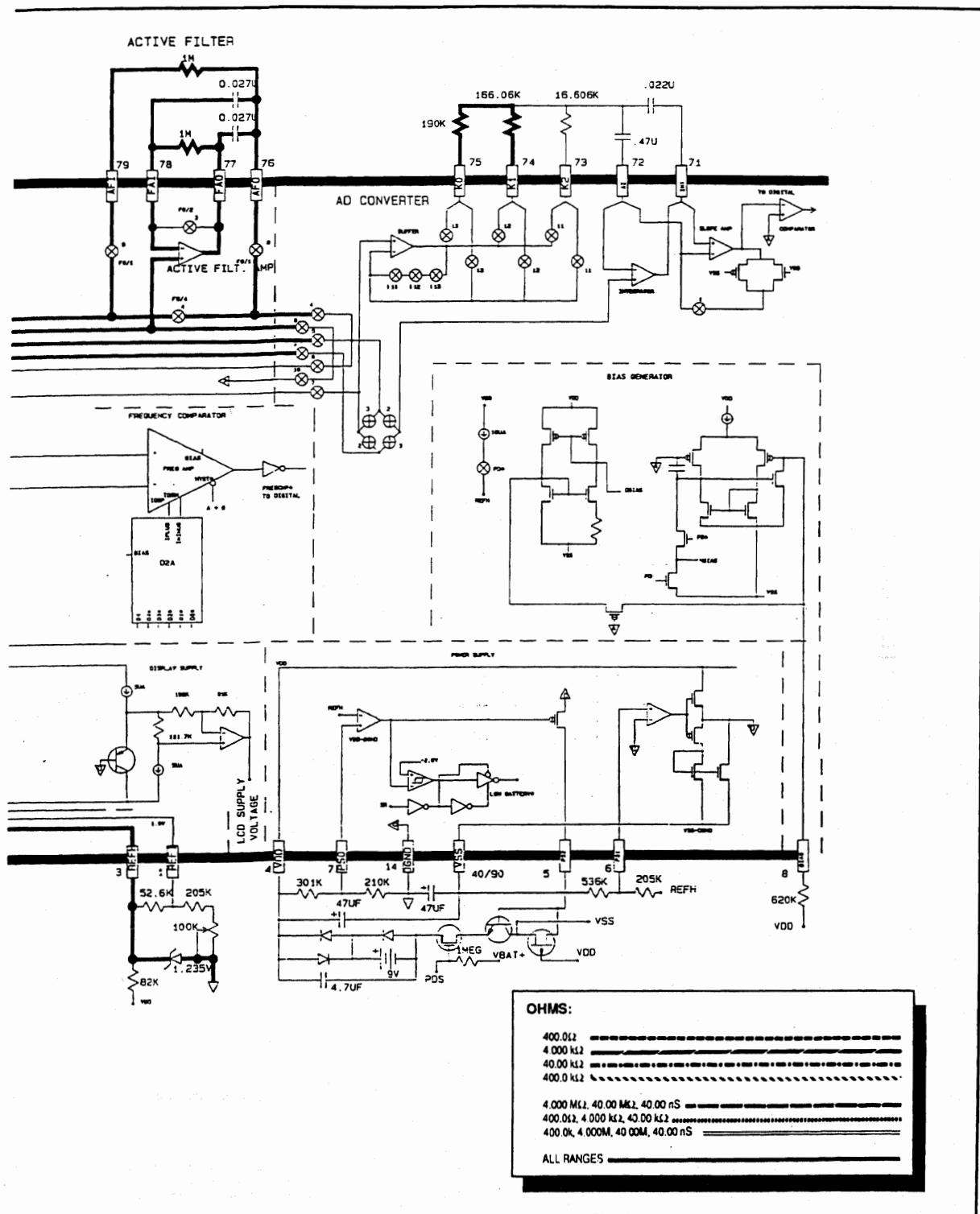
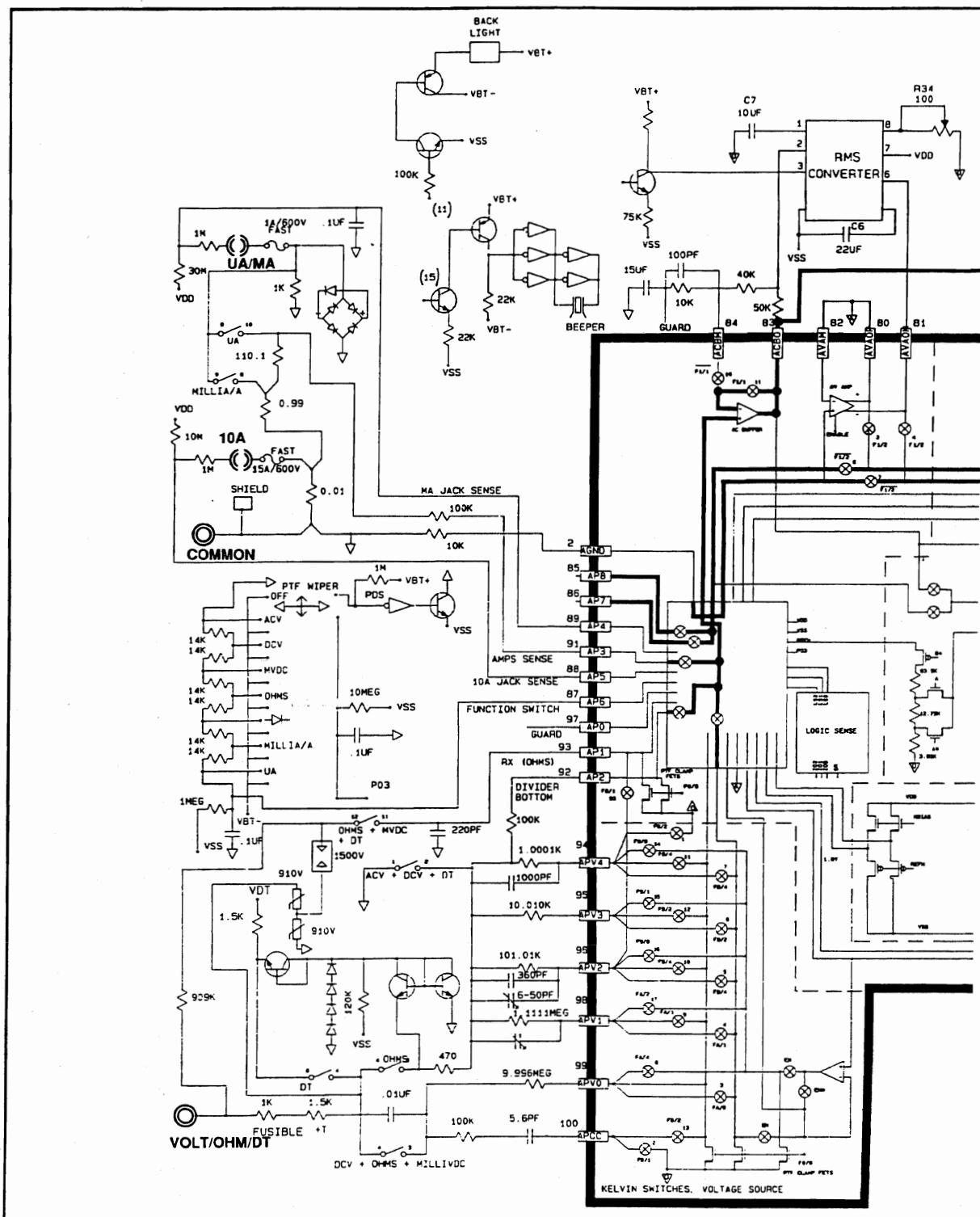
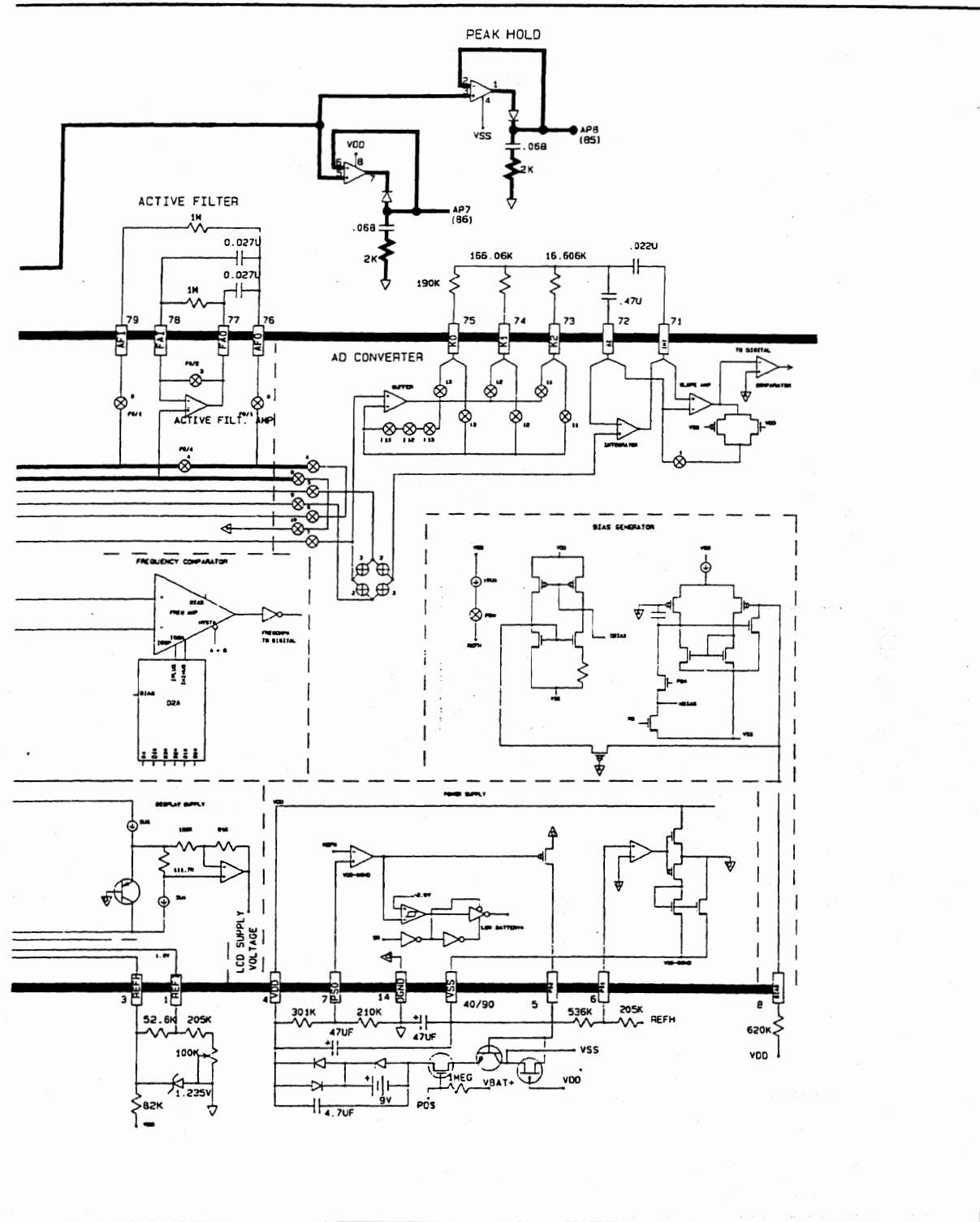


Figure 5-11. Ohms Signal Flow





**Figure 5-12. Peak/Hold Signal Flow (Model 87)**



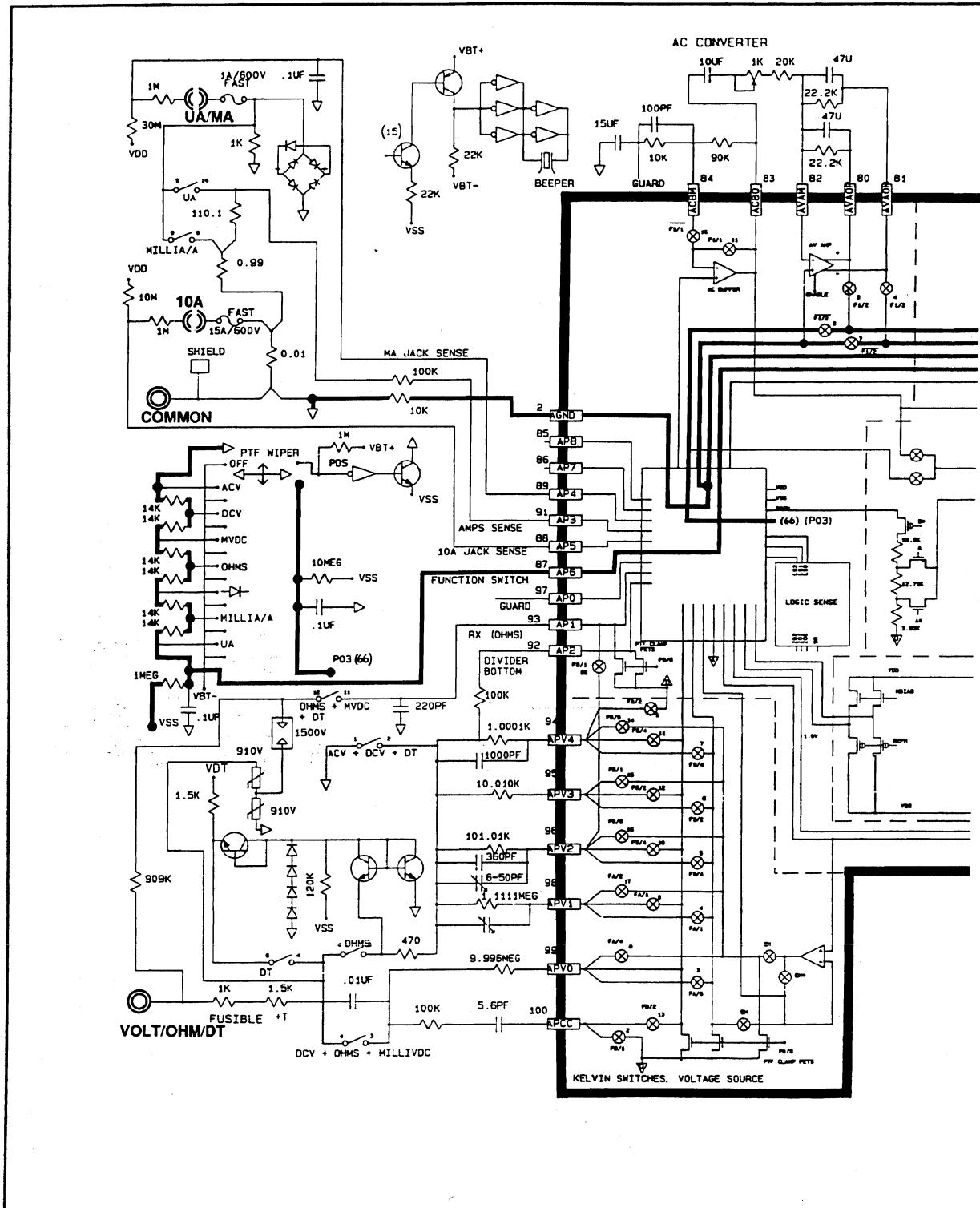
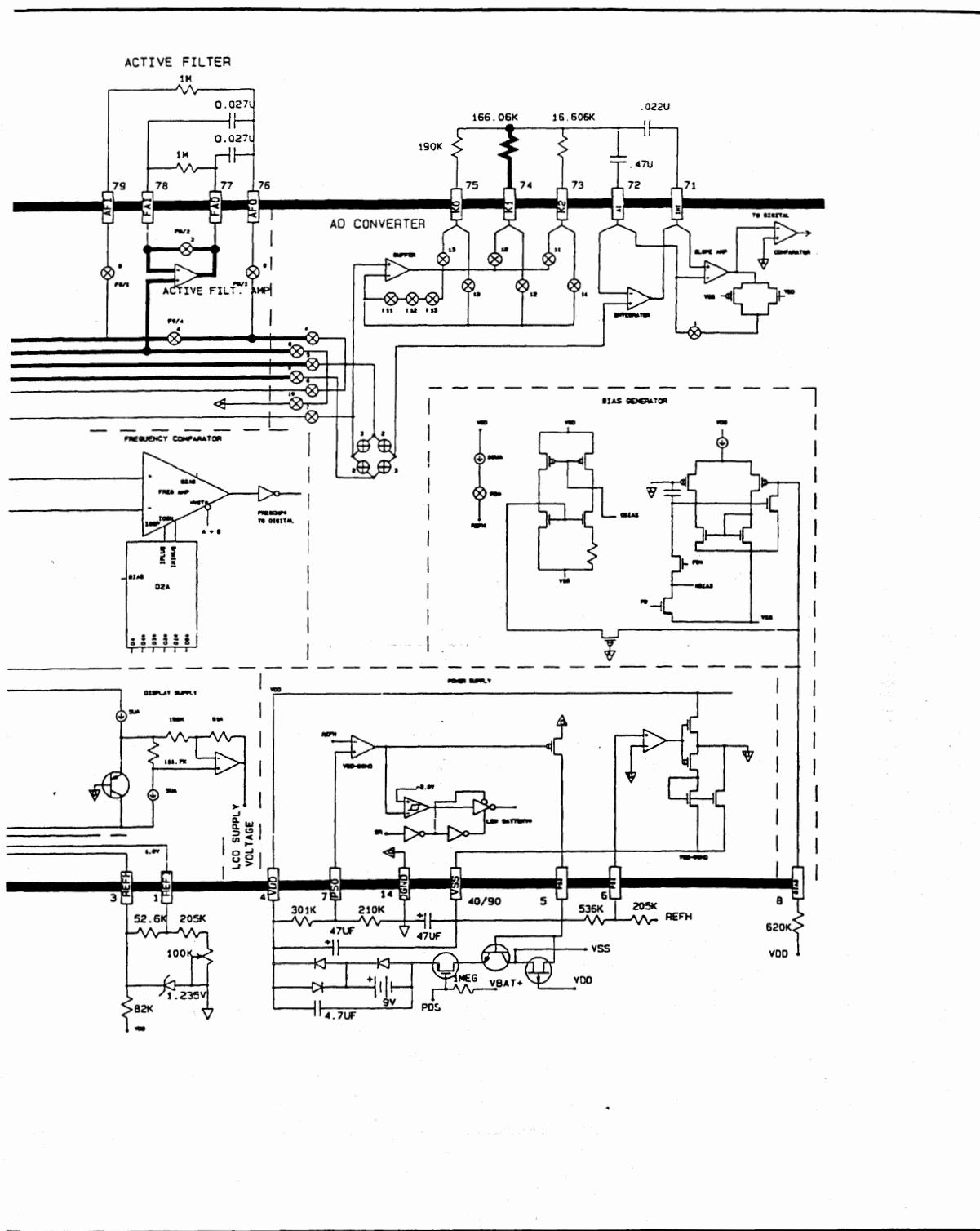


Figure 5-13. Function Switch Range Signal Flow



#### LIMITED WARRANTY & LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is three years and begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Fluke's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable International price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge, repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest Fluke authorized service center. Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

**THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, WHETHER ARISING FROM BREACH OF WARRANTY OR BASED ON CONTRACT, TORT, RELIANCE OR ANY OTHER THEORY.**

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation  
P.O. Box 5090  
Everett WA  
98206-9090

Fluke Europe B.V.  
P.O. Box 1186  
5602 B.D.  
Eindhoven  
The Netherlands

#### MULTIMETER SAFETY

The Fluke 83, 85, 87 Multimeters have been designed and tested according to IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus. This manual contains information and warnings which must be followed to ensure safe operation and retain the meter in safe condition. Use of this equipment in a manner not specified herein may impair the protection provided by the equipment.

These multimeters comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these multimeters may not cause harmful interference, and (2) these multimeters must accept any interference received, including interference that may cause undesired operation.

Some common international electrical symbols used in this manual are shown below.

	AC - ALTERNATING CURRENT		DANGEROUS VOLTAGE
	DC - DIRECT CURRENT		EARTH GROUND
	EITHER AC OR DC CURRENT		SEE EXPLANATION IN MANUAL
	FUSE		DOUBLE INSULATION FOR PROTECTION AGAINST ELECTRIC SHOCK

Before using the meter, read the following safety information carefully. In this manual, "WARNING," is reserved for conditions and actions that pose hazard(s) to the user; "CAUTION," is reserved for conditions and actions that may damage your meter.

- Avoid working alone.
- Follow all safety procedures for equipment being tested.
- Inspect the test leads for damaged insulation or exposed metal. Check test lead continuity. Damaged leads should be replaced.
- Be sure the meter is in good operating condition.
- Select the proper function for your measurement.
- To avoid electrical shock, use caution when working above 60V dc or 30V ac RMS.
- Disconnect the live test lead before disconnecting the common test lead.
- Disconnect the power and discharge high-voltage capacitors before testing in  $\Omega$  and  $\rightarrow$   $\rightarrow$ .
- When making a current measurement, turn the circuit power off before connecting the meter in the circuit.
- Check meter fuses before measuring transformer secondary or motor winding current. An open fuse may allow high voltage build-up, which is potentially hazardous.
- Use clamp-on probes when measuring circuits exceeding 10 amps.
- When servicing the meter, use only the replacement parts specified.
- Do not allow meter to be used if it is damaged or if its safety is impaired.